National Bureau of Standards
Library, N. W. Bldg.
JUN 2 1949

tech engineering news

may 1949

"Madame X" was the code name, during research and development, for an entirely new system of recorded music . . . perfected by RCA.

The remarkable background of "Madame X"

Now the identity of "Madame X", the unknown in a long search for tone perfection, has been revealed. From this quest emerges a completely integrated record-playing system—the first to be entirely free of distortion to the trained musical ear . . .

The research began 11 years ago at RCA Laboratories. First, basic factors were determined—minimum diameters, at different speeds, of the groove spiral in the record—beyond which distortion would occur; size of stylus to be used; desired length of playing time. From these came the mathematical answer to the record's speed—45 turns a minute—and to the record's size, only 6⅞ inches in diameter.

The record itself is non-breakable vinyl plastic, wafer-thin. Yet it plays as long as a conventional 12-inch record. The new RCA Victor automatic record changer accommodates up to 10 of the new records—1 hour and 40 minutes of playing time—and can be attached to almost any radio, phonograph, or television combination. The record *player* ends faulty operation, noise, and cumbersome size. Records are quickly changed . . . RCA Victor will still supply 78 rpm instruments and records.

This advance is one of hundreds growing from RCA research. Such leadership adds value beyond price to any product or service of RCA and RCA Victor.

Continue your education with pay—at RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to National Recruiting Division, RCA Victor, Camden, New Jersey.

Also many opportunities for Mechanical and Chemical Engineers and Physicists.

RCA

RADIO CORPORATION of AMERICA

World Leader in Radio—First in Television

And the Termites cheered too!

SMALL WONDER! Wood stands, like those above that are exposed to damp, rainy weather and snow, rate high on the termite menu. In fact, it's safe to assume, all wood is considered fair game by termites.

Dow produces PENTAchlorophenol to protect wood from the termite menace, as well as from decay due to excessive moisture. Wood protected with "PENTA" lasts years longer than untreated wood! "Wherever wood is used, consider the advantages of PENTA-protected lumber" is a phrase of increasing significance to the farmer, home builder and industrialist. The chemical PENTAchlorophenol is also used in the preservation of hemp, jute, and other cellulosic products that are often exposed to severe climatic conditions.

This is but one of more than 500 essential chemicals Dow produces. It has, however, *one characteristic common to all Dow products.* That is its high, uniform quality—a characteristic that has made the name Dow a standard in the chemical industry.

DOW

CHEMICALS INDISPENSABLE TO INDUSTRY AND AGRICULTURE

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit • Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle • Dow Chemical of Canada, Limited, Toronto, Canada

Photography can make this page

this small

IT'S DONE WITH MICROFILM MAGIC

TINY AS IT IS, the little rectangle above is this page—as it appears on microfilm. Everything there, condensed to a mere spot, but ready to be brought back full size with all its features intact. For photography can reduce tremendously without losing a detail.

As a business or professional man, you can utilize photography's reducing ability in any of many important ways.

You can utilize it to save space . . . to speed reference. With Recordak microfilming, you can "debulk" files 99% . . . keep the records at hand for quick viewing, full size, in a Recordak Reader.

You can utilize photography to make sales presentations more complete, more resultful. With motion pictures, you can "pack" a plow, a plant, a whole process into a small can of film . . . travel it where you will, show it off "large as life" and much more dramatically.

Only a suggestion . . . this . . . of what photography can do because it is able to condense. And because it has many other unique characteristics as well, photography is becoming an increasingly important tool all through science, business, and manufacturing.

Whenever you want to improve methods of recording, measuring, testing, teaching, or countless other functions, be sure to consider the unusual abilities and advantages of photography.

Eastman Kodak Co., Rochester 4, N. Y.

Functional Photography

—is advancing business and industrial technics.

Kodak

"—The real essence of work is concentrated energy —WALTER BAGEHOT

Why construction gets better all the time

WHERE ROADS were once built a shovelful at a time . . . today mammoth earth-movers handle a ton of earth at a time. Mobile cranes swing 20 tons at the flick of a switch. Giant crushers grind 150 tons of rock an hour. Traveling concrete mixers place entire batches as they go.

These are just a few of our improved powered tools of today that do a better job of construction *faster* and *easier*. They help provide us with critically needed new housing and business buildings . . . with super-highways and airfields for safer, smoother travel. And these tools are ours today because of *better materials* . . . and continuing research.

Alloy steels, for example, give them greater strength to resist shock and abrasive action . . . stamina to overcome the strain of day-by-day speed-up demands. And modern oxy-acetylene processes for welding and flame-cutting speed production of these better products of better steel.

Carbon is in the picture, too. In the form of electrodes, it's essential both to the production of alloy steels and the making of calcium carbide . . . from which comes acetylene gas for welding. Also, a chemical known as an *amine* provides a wetting agent for asphalt . . . speeding construction by making the asphalt stick more easily and firmly to its crushed rock base.

The people of Union Carbide produce these and many other materials essential to today's better building and construction. They also produce hundreds of other materials for the use of science and industry, to help meet the needs of mankind.

FREE: *You are invited to send for the new illustrated booklet, "Products and Processes," which describes the ways in which industry uses UCC's Alloys, Chemicals, Carbons, Gases, and Plastics.*

UNION CARBIDE
AND CARBON CORPORATION
30 EAST 42ND STREET UCC NEW YORK 17, N. Y.

Trade-marked Products of Divisions and Units include

ELECTROMET Alloys and Metals • HAYNES STELLITE Alloys • PREST-O-LITE Acetylene • LINDE Oxygen
BAKELITE, KRENE, VINYON, and VINYLITE Plastics • SYNTHETIC ORGANIC CHEMICALS • PYROFAX Gas
ACHESON Electrodes • NATIONAL Carbons • PRESTONE and TREK Anti-Freezes • EVEREADY Flashlights and Batteries

the tech engineering news

May 1949
Vol. XXX No. 7

Cooperative Education in Action 6
By Victor H. Pomper, '48

Mainline 9
By H. A. Schneider, '48 and W. Marvin, '50

The Sidewalk Superintendent at Tech 11

Diesel's Latest 12
By Helmut Weber, '50

Night and Day 14

The Whirling Weight 16
By Graham Sterling, '49

Lightning Quick 18
By Robert J. Horn, '48

From the Editor's Notebook 21

Briefing the News 42

Cover Design by Charles M. Jordan, '49

MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

Published monthly during the school year at Walker Memorial, Cambridge 39, Massachusetts, by the undergraduates of the Massachusetts Institute of Technology. Entered as second class matter, at the Post Office, June 1, 1920, at Boston, Massachusetts under the Act of March 3, 1879. Copyright 1948 by The Tech Engineering News. Subscription per year $1.50. Foreign $2.25. One copy 25 cents.

co-operative education in action

By Victor H. Pomper, '49

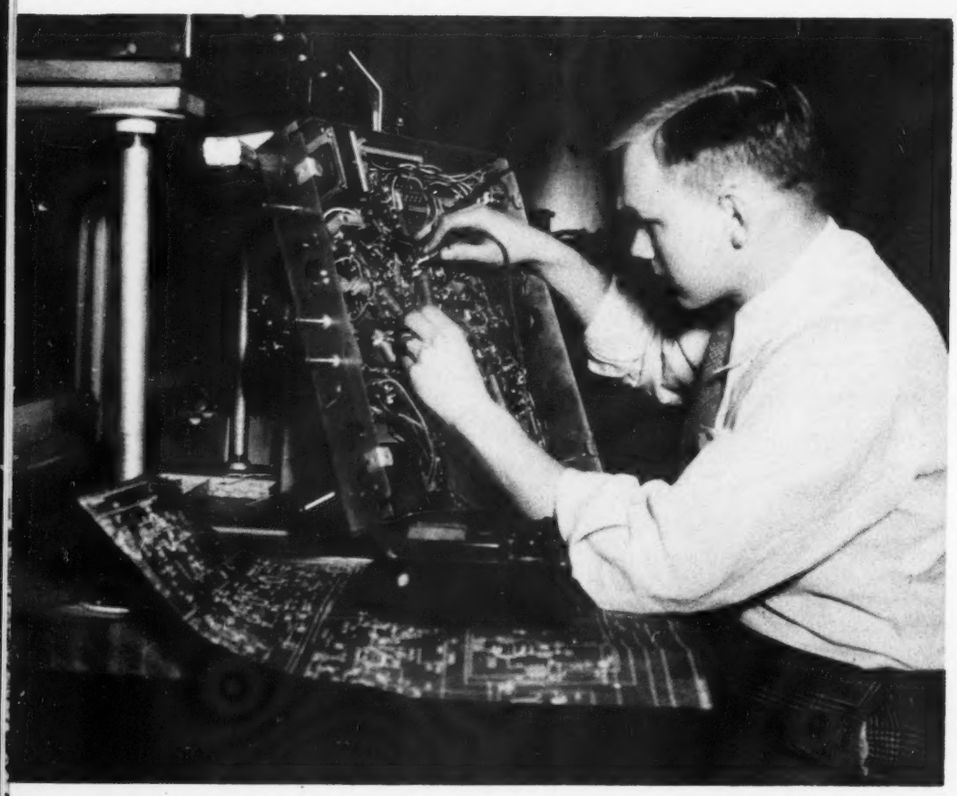
Course VI-A Has Numerous Values

Co-operative education affords the best technical training obtainable, for co-operation bridges the gap between engineering practice and the requirements of sound engineering education. Industry, primarily concerned with results, often criticizes the colleges for graduating men with an unduly theoretical approach. However, a four-year college program must necessarily emphasize theory in order that the student receive a sufficiently broad and fundamental professional background. College laboratory experiments can but imperfectly co-ordinate the conflicting demands of practical application and theoretical education, for experiments tend to be weak and somewhat artificial shadows of industrial processes. In addition, college laboratories cannot keep pace with the rapid advances of industrial technology. The college graduate must therefore expect to serve an engineering apprenticeship in order that he become accustomed to the pace and methods of industry. Unfortunately, during this acclimatizing period much of the abstract theory may slip from his grasp through lack of use and imperfect assimilation, for a fundamental principle of the learning process is that abstractions must be applied if they are to be understood and retained. Although industry, the college, and the student are apparently faced with a formidable dilemma, co-operative education makes possible having the educational cake as well as eating it.

The co-operative plan, whereby students alternate between college and industry, was first instituted at the University of Cincinnati in 1906. Although co-operative programs vary considerably, basically they are variations of two educational methods. Briefly, the first plan stresses periodic leaves of absence from academic work for employment in fields which may be unrelated to the student's studies. Therefore, although the student acquires valuable experience in industrial methods, co-operation here is primarily a means of financing further education. The alternative plan considers co-operation an integral part of the educational program. The college and co-operating company jointly select industrial assignments to conform most nearly with the student's interests, academic specialty, and stage of education. Since the student co-operates with but one company, his development may be more closely supervised in order that he be aided in determining the work most nearly suited to his abilities.

This second plan is admirably illustrated by the Co-operative Course in Electrical Engineering at M. I. T., a conspicuous educational success for almost three decades under Professor W. H. Timbie. The plan in operation is both simple and effective.

Each year the several co-operating companies interview and select second-term sophomores on the basis of technical promise, personality, and grades. For a three-year period the successful candidates alternate four-month terms between M. I. T. and the laboratories



Trouble shooting is part of the budding engineer's job.

and offices of the co-operating company. Continuity of theoretical education is maintained by evening classes during the work terms, and, upon successful completion of the program, the degrees of Bachelor of Science in Electrical Engineering and Master of Science in Electrical Engineering are awarded. The graduate, by virtue of some sixteen months of varied engineering experience, is qualified to apply the more advanced theory of his senior and graduate years to responsible engineering practice.

The Co-operative Course at M. I. T., now under Professor E. W. Boehne, offers many advantages to the engineering student. Pre-graduation professional apprenticeship, substantial earnings, the increasingly important master's degree, and frequent changes of scene and pace are noteworthy advantages. However, chief emphasis should be given the program's unsurpassed educational opportunities. Theory at M. I. T. has added significance and interest after industrial experience, and in turn, engineering application of this theory extends and consolidates the student's grasp of fundamentals. Of particular importance is the opportunity to acquire a perspective of many different phases of engineering activity and so determine that work best suited to individual aptitudes and interests. Professional careers founded on such concrete knowledge have greater prospect for success than those in which the engineer flounders aimlessly from job to job before finding a suitable position.

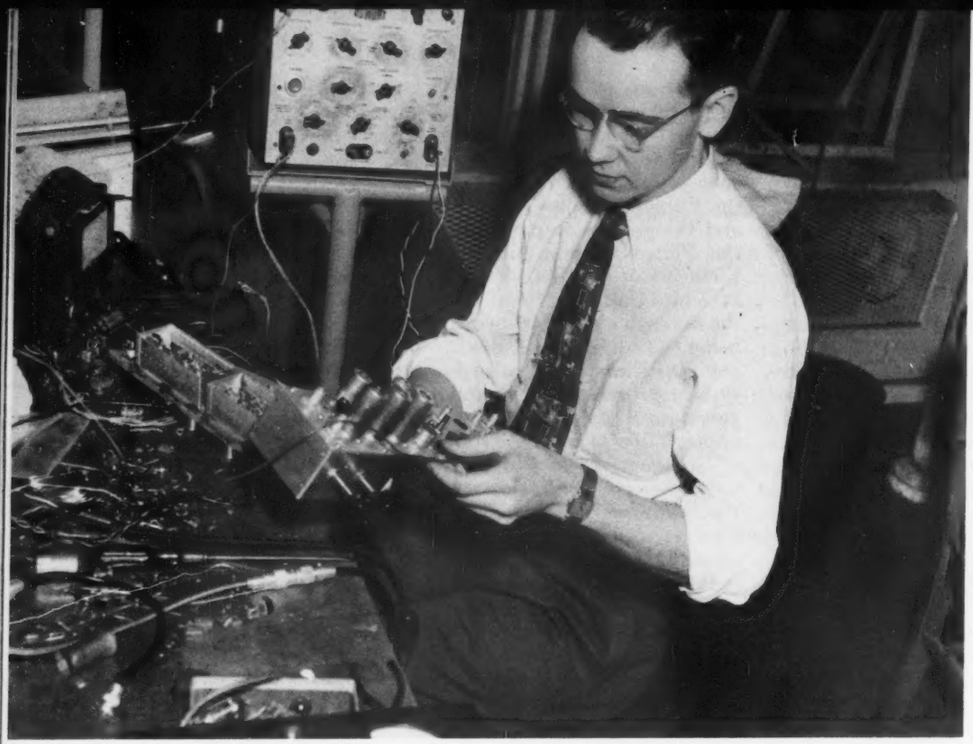
This early orientation is particularly emphasized in order that the student be aided in selection of advanced studies directed to some specialty in electrical engineering. Ideally, eventual specialization in this broad field should be based on careful evaluation of individual abilities and interests. To this end the co-operating companies have been carefully selected to offer the widest possible range of experience against which to weigh personal characteristics. Although particular companies emphasize classifications such as power, electronics, or communications, experience with each company is further subdivided into manufacturing, production planning, quality control, development engineering, design engineering, and research. Each student, then, may obtain as broad a background as desired with any one co-operating company. Experience is offered with the General Electric Company, the Boston Edison Company, the American Telephone and Telegraph Company, the General Radio Company, the Philco Corporation, and the American Gas and Electric Corporation. The Naval Ordnance Laboratory at White Oak, Maryland, is shortly expected to become the seventh co-operating organization. The operation, benefits, and opportunities of the co-operative program are best illustrated by reviewing co-operation with a typical progressive company such as the Philco Corporation, a nationally known organization offering opportunity to a large group of co-operative students.

Assignments at Philco are made only after one or more personal conferences which determine, if possible, the position best suited to the individual's ability, interest, and experience. Insofar as is practical, every effort is made to match men with jobs, for experience indicates that students benefit from particular assignments in direct proportion to the enthusiasm aroused by the work. Philco feels that the co-operative terms are primarily educational periods, and therefore assignments to routine production are avoided. Most students find their work stimulating, although occasionally a man may decide, on the basis of co-operative experience, that his talents lie in fields other than engineering. Co-operation, then, affords both valuable industrial experience and opportunity to evaluate engineering as a career before entering the more specialized phases of technical education.

Individual work, under the direction of experienced men, is a part of later terms in the co-operative course.

The emphasis on student education rather than on immediate productive capacity leads to progressively more advanced assignments in several departments throughout the organization. Each plant term thus offers both a challenge and a new view of some phase of Philco operations.

The first co-operative term is generally spent in the development engineering laboratories. Wiring, solder-



Design and construction of new circuits is another phase of co-operation at Philco.

ing, drafting, construction, and simple design under the guidance of experienced engineers serve to acquaint students with engineering practice. Here the co-operative engineer begins to appreciate the importance of co-operative attitudes toward associates. Students find that the practical experience aids considerably in comprehension and assimilation of subsequent theory at M. I. T.

The second term at Philco is usually spent in test engineering where students receive greater responsibility in actual design of the test equipment used by workers on the assembly lines. Further experience is available in mass-production techniques of radio and television-receiver manufacture.

By the third co-operative period the student, now a senior, has a sufficiently broad theoretical and practical background to attack more advanced projects in the research division. The activities of this division include fundamental investigation of physical phenomena, development of new and improved circuits, and mathematical study of communication principles. The co-operative engineer generally works on an individual project under the supervision of Philco's research staff. This assignment is particularly popular for it affords opportunity for real creative work in a completely professional atmosphere.

The fourth and last term finds the graduate student employed in a more responsible capacity by one of the departments previously mentioned. This assignment usually involves projects of particular interest to the individual student, and men with special qualifications often receive graduate thesis credit for their work. In some cases, the last co-operative term may be spent with the patent office, the technical reports section, or with some group engaged in activities more closely allied to business than to engineering.

To afford co-operative students a more comprehensive view of industrial operations, Philco offers an optional evening orientation program. One hour a week is devoted to lectures by company executives who review all phases of Philco activity including patents, industrial relations, sales, and business administration. Trips to other Philco plants may be arranged, and, in addition, students are eligible to attend weekly research seminars which keep the technical staff informed of new developments.

An integral part of the co-operative course is evening study while at Philco. Studies are identical to corresponding subjects at M. I. T. and students receive M. I. T. credit and grades for their work. Research engineers, often leading men in their field, are instructors in this program, and a considerable selection of courses is available. The courses offered are arranged prior to each plant term in order to best meet student academic requirements. A typical schedule consists of one three-hour class and two evenings of home study per week.

Industry has a tremendous stake in the effective utilization of its human resources. On every industrial level, the efficiency of operations is limited by the efficiency of the men and women engaged in these operations. In the final analysis, however, the performance of a relatively few men in key positions will determine the economic success or failure of the entire organization. In engineering, for example, a small group of gifted individuals may be the creative heart of large engineering and research organizations. As technology expands in scope and complexity, it becomes of the utmost importance that industry early recognize and develop exceptional talent, be it in mathematics or management.

Industrial co-operation permits industry to select men of high promise, to observe their performance in a variety of tasks, to weed out the inevitable misfits, and finally to place the co-operative graduates in positions where they will be happiest and of most value to the company.

Granted that the administration and operation of an effective co-operative program entails a considerable financial burden to the company with but little return as reckoned in cold hard balance sheet entries; granted that the co-operative graduate, by virtue of varied experience, may command a higher salary from the very company which trained him; still, from a long range view, industry stands to gain by earlier recog-

(*Continued on page 32*)

mainline

By H. A. Schneider, '48 and W. Marvin, '50

Six Men on Control Panels

The primary purpose of model railroading is the construction and operation of a scale model of a section of a typical railroad. To this end, engineering methods closely allied to those required for real railroad construction are utilized. Among applications of these methods, three stand out: track planning and construction, control, and operation.

The Tech Model Railroad Club's track layout includes a large storage terminal running out onto a mainline which serves various industrial sidings and way stations. This design provides a realistic basis for operation.

As the design of the layout proceeded, various secondary purposes were built into it — the illusion of greater length by use of straight sections and wide curves, different track levels to provide realism, efficient use of available space without crowding the tracks, specific sections for the benefit of spectators.

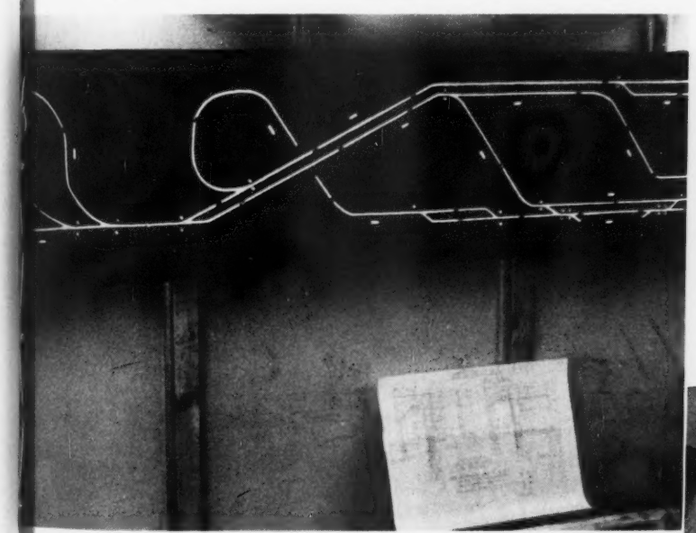
The layout provides for both continuous running and what is known as 'point-to-point' operation. The former has little resemblance to prototype operation and is useful primarily for breaking in new locomotives and in providing a route for 'through' trains when the system is operating under a timetable. Point-to-point operation is true to life in that a train starts somewhere and has a definite destination. The mechanics of operation will be discussed presently; here, only the design and construction of the track work is of interest.

The yard and terminal facilities presented the most complex design problems. In the Club's experience it was found desirable to incorporate into the yards not only storage trackage but sufficient extra track to permit the making and breaking of trains by switching engines without interrupting operation on the mainline. An examination of the yards therefore shows the presence of so-called 'make-up' tracks (Nos. 5 and 21) in the freight and passenger yards respectively, that will accommodate an average length train. In addition, routes must be provided for trains to enter or leave the yards without difficulty; the three crossovers, adjoining the mainlines (Nos. 1 and 3) in the freight yard provide them in as small a space as possible. Engines must have a clear path into the engine yard without disrupting other train movements. A passing siding (No. 4) is necessary for any trains that have been delayed. The criterion followed in the yard design was the minimizing of operational delays and interruptions.

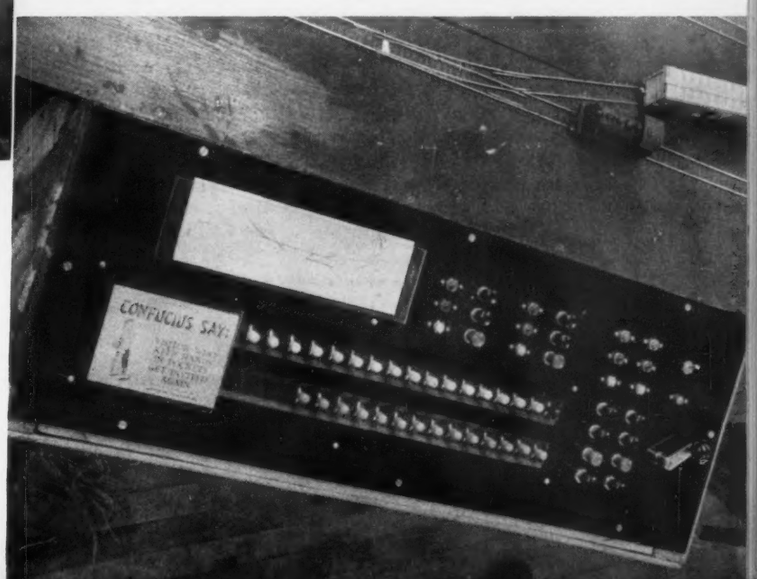
Careful construction of track work is the best precaution against derailments, especially in 3.5 mm. scale, where tolerances are on the order of several thousandths of an inch. The track sites of the Tech Nickel Plate were laid out with line and level, the baseboard built up to the proposed rail height, pine roadbed fastened down, and the rails gauged and spiked accurately. Wherever trains were expected to exceed 25 scale m.p.h., the curves were laid in a gradual transition from the straight track in an approximation of a true spiral. On comparatively tight curves the gauge was widened slightly to minimize the friction binding of long cars. Grades have been kept to within the abilities of the type of train expected to traverse them — mainline grades are kept to 2%, and lines used only as down grades do not exceed 3%.

Turnouts are built from stock rail by the Club for a fraction of the cost of commercial switches. Each switch is fitted specially to its location, giving it an added measure of operational dependability.

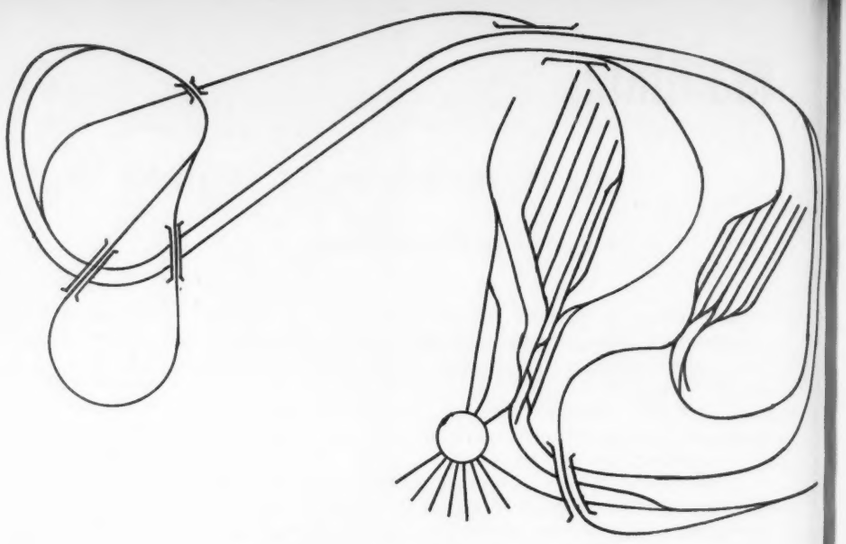
A foolproof automatic control system, although easily devised, is not true to life because even today the human element is still present in real railroad



This general indication board allows all of the operating staff to see what is happening over the layout.



Shown here is the freight yard control panel of the HO gauge layout of the Tech Model Railroad Club.



The track plan of the "Tech Nickel Plate Road" shows it to be a complex set-up.

operation. Hence the installation of automatic train control in the layout was rejected. Carrying the idea of realistic procedure still further, the Club decided that operational tasks should be as diversified as possible. The control boards were laid out in such a way as to permit the simultaneous operation of five locomotives entirely independently from each other over any portion of the right-of-way and the yard facilities.

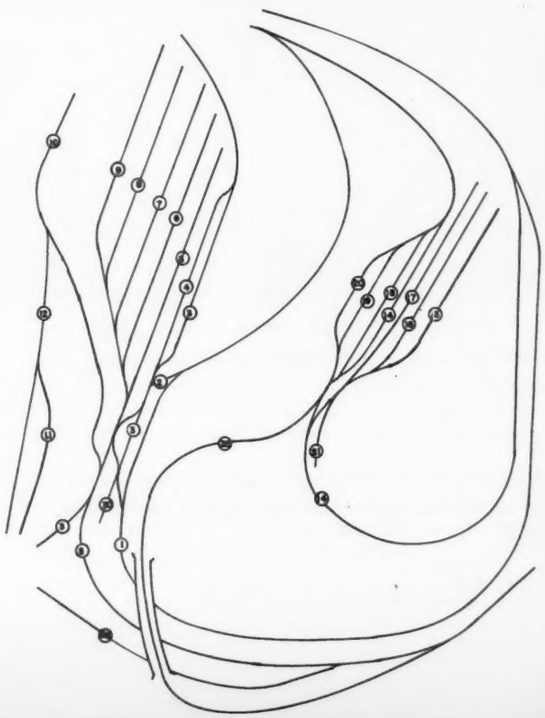
While the controls are all simple in design, their number makes the system appear confusing. On these pages, therefore, an attempt will be made to indicate the basic operation of the system, both as regards the application of power to the track sections for train movements, and the circuitry used to operate track switches.

Figure 4a represents in schematic form the electric circuit used for the control of power and for the automatic occupancy indication by lamp signals. In order to achieve these purposes simultaneously, two complete electric circuits are superimposed on each other, and a selenium rectifier is used to prevent interference between the two. The power circuit consists of a 12 V. battery, a power switch, a rheostat for speed control, the rectifier, and the wire connection to the track. If a locomotive is in the block, its motion can be controlled by means of the power switch and the rheostat. To permit reversal of travel direction, a d. p. d. t. switch or relay can reverse its direction. The second circuit, for occupancy indication, uses the 12 V. battery, a 24 V. battery and the relay. If the block is empty, this circuit will be open, and no indication is shown. However, if a train is in the block, that is, an engine or a car with a resistor shunted across the wheels, a current of a few milliamperes will energize the occupancy relay. This completes lamp indication circuits which operate regardless of whether power is applied to the tracks or not. The method described is used for every block in the mainline.

The problem of multiple control can be solved in a number of ways. The design finally adopted was one which was operationally very useful and at the same time financially acceptable to the Club. The question was this: how can power application and current direction to the tracks be controlled by two or more persons from different locations without interference? In the main, the significance of the switch positions is a function of all other switches, and the inclusion of additional switches requires extensive rewiring. The system accepted, therefore, uses spring-return pushbuttons and locking relays. Fundamentally, however, the basic idea will still be as follows: to energize a relay from different locations, normally open pushbuttons in parallel are used. To release a relay, series connections of normally closed pushbuttons are employed. This, then, is the method used which permits a mainline engineer to bring his train into a designated block, stop it, and to have it taken over by the frieght yard master or passenger yard master.

To control turnouts from remote locations, relays can be used very effectively. For instance, the track switch can be adjusted to rest in one position when the relay is not energized and in the other when it is. While this system is used on many model roads, the Club decided on an entirely original switch machine which has a number of features that are not commercially available. Primarily to conserve power and to

(*Continued on page 24*)



In this yard are made up the trains which traverse the main lines of the "Nickel Plate."

the sidewalk superintendent at tech

By Donald R. Bresky, '49

Introduction

The several construction projects going on about the campus at this time furnish superior opportunities for both the experienced sidewalk superintendent[1] and the novice at this time-consuming and most interesting occupation.

Analysis

It has been observed, however, that the number of such observers at the several jobs about campus has hardly been as great as would ordinarily be expected considering the rather large pedestrian traffic around the campus. This paucity of construction theorists can be attributed to several causes:

1. Failure of the contractors to provide suitable viewing positions and welcome for the sidewalk superintendents.[2]
2. The possible attitude of the embryo engineers of M. I. T. that they are on a much too high a professional plane to be found in the practical occupation of sidewalk superintending.
3. The refusal of staff members to show any practicality outwardly where such behaviour might be observed, lest the Institute come to be known as a trade school.
4. The possibility that severe demands on the students' time results in frustration of the propensity toward sidewalk supervision.[3]
5. The failure to fence-in (with solid-board fencing) the construction areas, thus preserving no secrecy and providing no knotholes or cracks through which the sidewalk superintendent can sneak a look at that from which he is excluded.[4]

Conclusion

The administration of M. I. T. should promote more interest in the science of sidewalk superintending. Is this science to become a lost art among the technically educated citizenry? No! The citizen of the future must be well-rounded[5] as an individual — sidewalk superintending must not be a neglected part of his education.

[1] The sidewalk superintendent can be defined as any person not in the construction business, and usually knowing no more about construction than that a hammer is used to drive a screw, who pauses for considerable time to observe and comment on the work going on about any construction job. The comment usually includes inexpert, expert opinion on the many errors being made on the job and in the design of the structure.

One must carefully distinguish between the sidewalk superintendent, as here discussed, and the pavement inspector whose job it is in cities other than Boston to condemn sidewalks when they have tripping hazards and/or when his favorite contractor friend needs some new pavement business.

[2] On the job of building the New England Mutual Insurance Company building on Boylston Street, Boston, in 1940–41 was an excellent example of contractor's courtesy to the sidewalk superintendents. Several booths complete with seats, sketches, and suggestion boxes were provided at strategic locations on the periphery of the foundation excavation. Such consideration was greatly appreciated by the many unofficial overseers on that job.

[3] This possibility is included merely for purposes of completeness since the Tech man is not frustrated, particularly not due to the lack of sufficient time to pursue activities which interest him. This subject is broad enough for treatment in a separate paper and so falls outside the scope of the present writing.

[4] Secrecy is, of course, a potent method for inducing interest in that which is secret.

[5] By well-rounded it is not meant physically curvaceous. Food alone does not make the man.

diesel's latest

By Helmut E. Weber, '50

At the turn of the Twentieth Century the modern diesel engine was in its infancy. Since that time it has been developed rapidly until today the amount of diesel power produced in the world is second only to steam power. Before going into a discussion of the Nordberg radial diesel engine, a few of the advantages and disadvantages of diesel as compared to steam power will be discussed.

Fuel costs in the generation of power are one of the most important considerations. Relative fuel costs for steam and diesel power fuel vary, of course, from one part of the world to another. However, above the 2500 h.p. range the fuel rate (pounds per hour) for the diesel engine remains at about a constant two-thirds that of the steam turbine; but as the horsepower requirements are decreased, the fuel rate for the diesel as compared to the turbine drops to about one-half. In the same range machinery weight as well as space required per horsepower also decreases for the diesel engine.

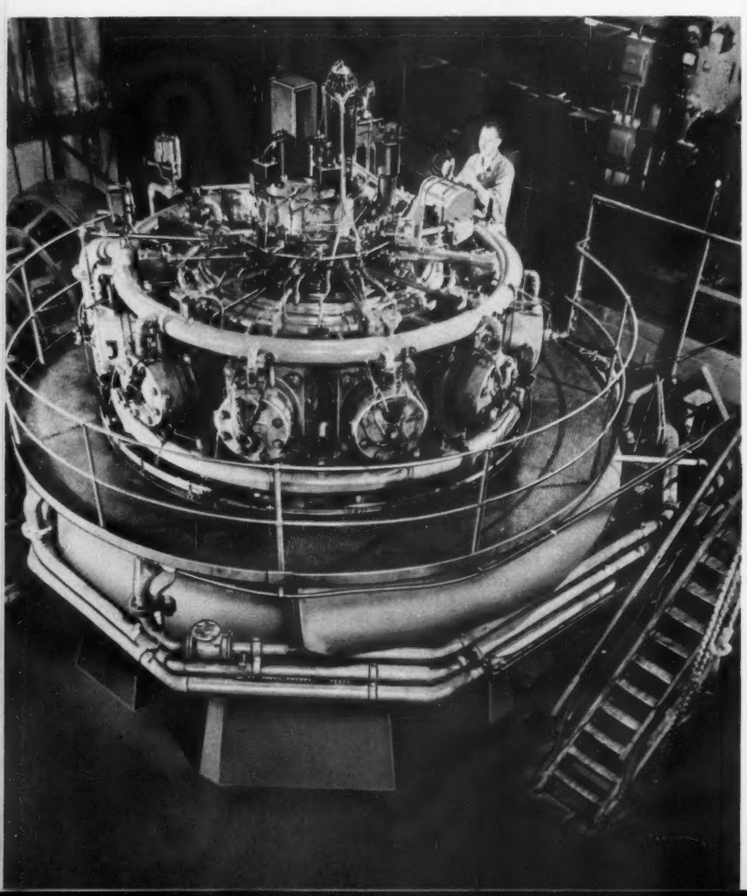
In the higher horsepower range the turbine enjoys a distinct advantage over the diesel engine in its low weight and unit cost per horsepower. Finally, although turbine maintenance costs are much less than those for the diesel engine, the latter requires a much smaller running crew.

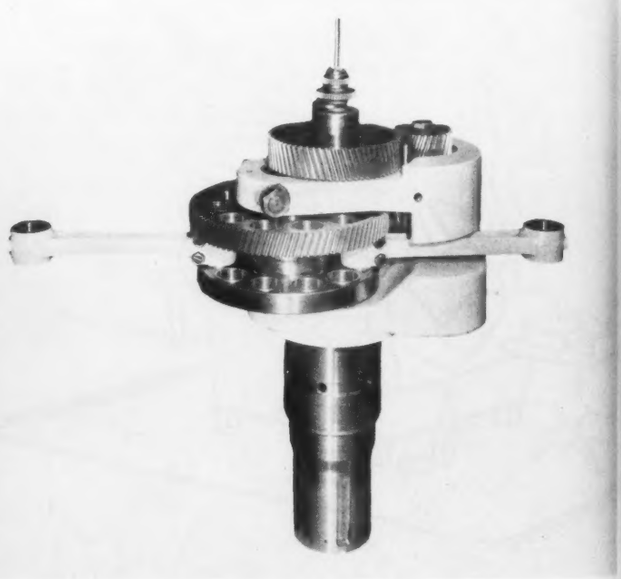
Consequently, with the increased demand for medium power units, where space, weight and cost are the determining factors, diesel power equipment has been developed rapidly since the period of World War I. The latest contribution to the diesel industry is the Nordberg Manufacturing Company's radial engine. Although classified as a diesel engine, it can be changed to run as a dual-fuel or spark-fired gasoline engine. The important features in its design are freedom from vibration, accessibility to parts and compactness, requiring less than eighteen feet head room from the foundation and but little more than twelve feet lateral space. The fact that the design is compact can be seen from the pictures and the fact that the weight per horsepower is only forty-seven pounds, an extremely low figure for a diesel engine.

Accessibility to all parts of the engine reduces the cost and difficulty of servicing and repair. Furthermore, the radial design eliminates the necessity for clearance above the engine to pull pistons. Freedom from vibration is a result of the engine's unique crankshaft drive which will be discussed more fully later.

The engine itself is a two-cycle, eleven cylinder type with fourteen-inch bore and sixteen-inch stroke. At its normal operating speed of 400 r.p.m. it develops 1800 h.p. or 1250 kw., 100 kw. of which are used for the operation of the scavenging blower motor. A generator is connected directly to the lower crankshaft.

The crank case is of one-piece cast iron construction with ribbed reinforcing. Also of cast iron is the two-





The crankshaft is of cast iron. Eleven connecting rods are attached to the master gear with eleven equally spaced knuckle pins.

Radial engine in operation. Two scavenging air lines feeding the cylinders encircle the engine. Scavenging air is taken in through the large pipes below the floor walk.

piece crankshaft. The lower portion of the crankshaft and load is carried by one main bearing bushing and thrust bearing in the central hub of the frame, while the upper portion runs in the other main bearing mounted in the frame cover. Inexpensive and easily replaceable main bearings are used in construction and are of the one-piece, removable, bronze-backed shell type lined with anti-friction bushings.

The cover containing the upper main bearing is bolted to the frame and mounted on it are the governor, fuel pumps, and oil and gasoline operation controls. The cover provides easy accessibility to the crankshaft, connecting rods and geared driving mechanism.

The patented gear mechanism employed to drive the crankshaft is probably the most remarkable feature of the entire design. Instead of the master rod usually associated with a radial engine, each rod is itself a master rod attached to the master gear by a knuckle pin riding in a bronze bushing. (See figure.) There are four gears in the system. The two pinions are bolted to the same shaft which rotates in the upper counter weight. The upper pinion meshes with a stationary gear bolted to the frame cover, while the lower pinion meshes with the master gear. The main crank pin rotates freely in the master gear.

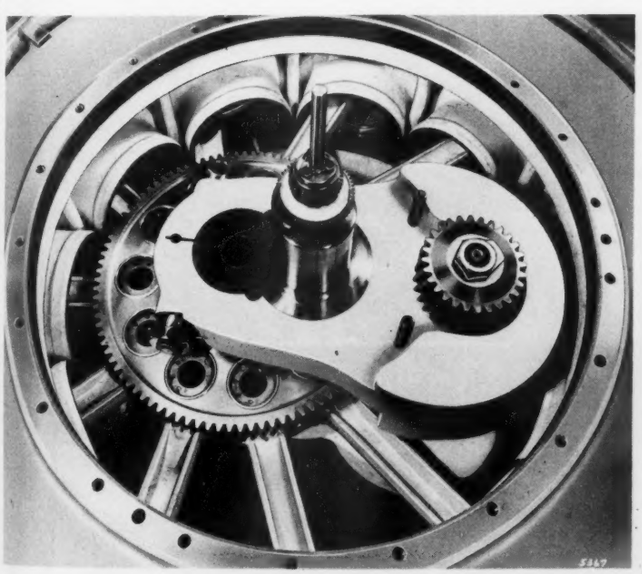
Facing the top of the gear drive, consider the connecting rods as they push the master gear in a counter-clockwise direction. As this action occurs the pinions rotate in a clockwise direction; and since the upper gear is stationary, its pinion is constrained to "walk" around it in a clockwise direction rotating the crankshaft clockwise with it. Therefore, the position of the master gear also moves in a clockwise direction with the crankshaft, as the master gear tends to rotate about its own axis in a counter-clockwise direction; and its motion is of a gyratory nature.

The gearing and positions of the connecting rods have been designed to maintain maximum efficiency in the absorption of thrust. The absorption of thrust in this design gives an extremely high balance of forces, eliminates the vibration associated with an internal combustion engine and makes possible the mounting of the engine on a simple and inexpensive foundation.

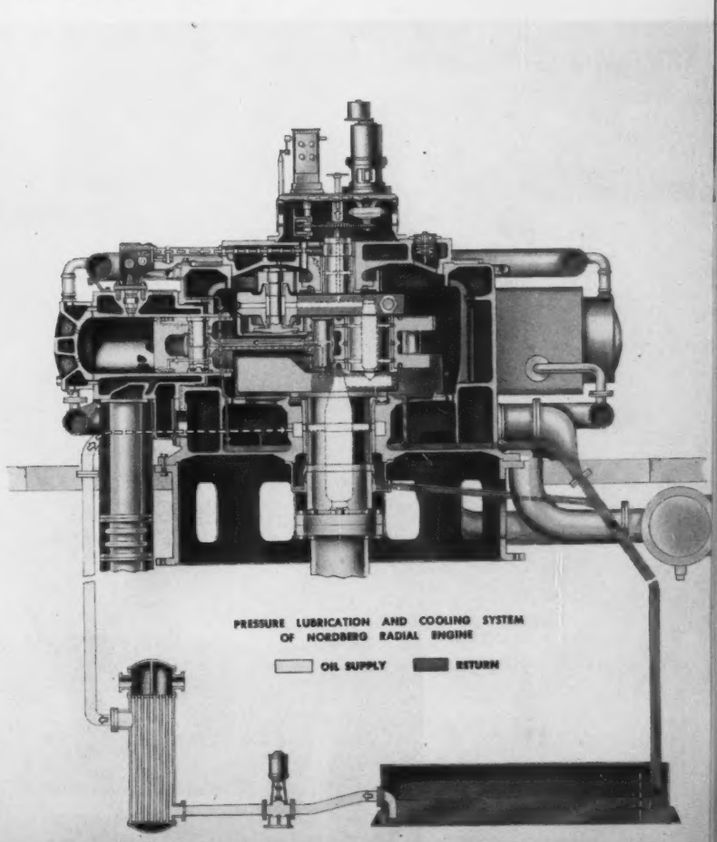
The engine embodies two lubricating systems. In the first, oil is supplied to the upper end of the cylinders at two points on their periphery by a multi-feed, motor-driven lubricator. The other lubricating system for the bearings is of the pressure-feed type which circulates oil to all other parts of the engine. Both webs of the crank shaft are drilled and cored to conduct lubricating oil to the crank pin, knuckle pins, wrist pins and to the oil-cooled pistons through a large drilled passageway in each connecting rod. (See figure.) The oil from the bearings and pistons now returns to the engine sump from which it is pumped through a cooler and recirculated.

The engine has been thoroughly tested and proved. Eighty of these engines have been ordered for the new Texas plant of the Aluminum Company of America and will be used to supply the Company's operations with 70,000 kw. It is intended to use natural gas as fuel.

In many ways the new design is a great improvement over existing diesel engine designs. Its compactness, low weight, and vibration-free operation permit small, low-cost power installations. Easy accessibility to all parts reduces difficulty and cost of maintenance. All cylinders, pistons, and heads are interchangeable, eliminating the necessity for storing and carrying large numbers of replacement parts. Finally, the engine permits the use of various types of fuel for operation. These added advantages combined with the usual desirable features of diesel power extend present fields and open new ranges of application of diesel engines for power generation.

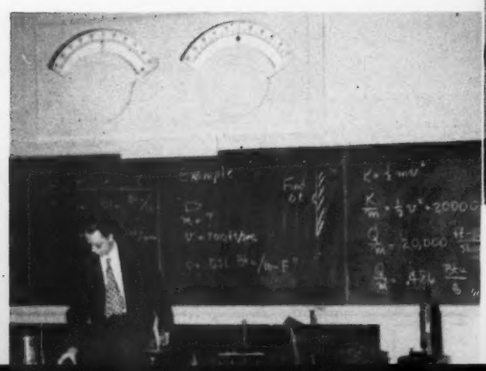


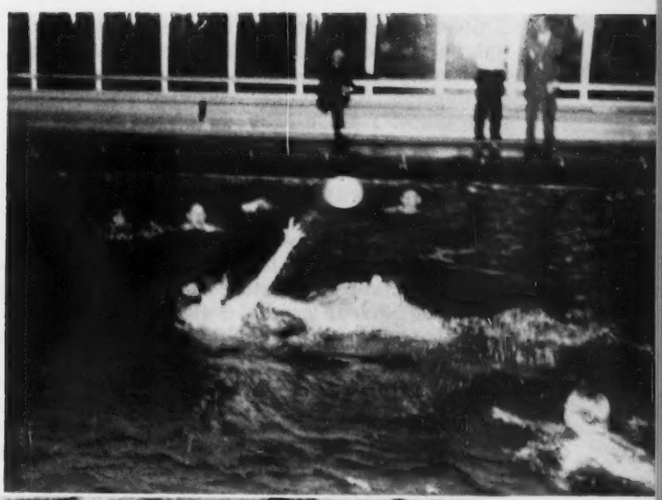
Assembly view of crankshaft drive. On top of the shaft are the fuel injection operating cam and governor gears.



Schematic view of the two lubricating-cooling systems. The crankshaft is cored to carry oil to the moving parts of the engine.

NIGHT AND DAY





the whirling weight

By Graham Sterling, '49

Flywheels for Large Scale Energy Storage

The need for storing energy in one form or another has impressed men since the discovery of fire, for at that time our ancestors must have realized the advantage of storing firewood in their caves in preparation for winter. Fuel storage is still the most important form of energy storage available to us, but as our civilization has become more mechanized, it becomes more desirable to store energy in a less bulky and more accessible form than raw fuel.

The extensive use of electricity as a means of conveying energy has posed the problem with particular force, because we are not prepared to use electric power at the constant rate at which it can be most economically produced, and because electric power cannot be stored as such in large quantities. A number of interesting methods of energy storage applicable to electric power systems have been developed, but because none of them has proven perfect, suitable, we will here point out the possibility of using, in this connection, a storage system consisting of a group of large, high speed flywheels.

Let us digress for a moment and consider the conditions under which energy storage may become desirable:

First, when energy becomes available to us at a variable rate not adapted to the normal rate of consumption, it may be relatively useless unless some means of storage is used to modify the power flow. An example of this would be a tidal power hydroelectric plant which could generate power only about half the time, that is, during the falling tide. Power availability dependent upon the time of falling tide is not an attractive selling point, so in order to be economically sound, a tidal power plant should have a considerable amount of associated storage capacity.

The second general situation calling for energy storage is encountered when it is necessary to use at a variable rate the energy from an essentially constant-power source. Unless we can store energy when the rate at which it becomes available is greater than the rate at which we can use it, much will be wasted; furthermore, the maximum rate of consumption of energy will be limited by the source unless storage is present. Steam-electric generating stations have constant flow characteristics under ideal conditions, but the demand from such plants is rarely even approximately constant. This results in inefficient use of apparatus and losses due to frequent starting and stopping of equipment.

The problem of providing energy storage in electric power systems for load factor improvement has long concerned electrical engineers. An obvious solution would be the use of storage batteries, and a number of such installations were made in this country about 1900. However, the introduction of alternating current, the rapid growth of electrical loads, and the high cost of batteries combined to make this system impractical.

Pumped water storage behind hydraulic turbines has been in use in Europe since 1880. A typical installation is at Niederwartha, Germany, where a storage plant uses off-peak power from nearby steam plants to pump water from a low reservoir to a higher one, the impounded water being released to drive hydraulic turbine-generator sets during periods of peak demand for power. Obviously such a plant requires a very large capital outlay, and for this and other reasons, such an installation has never been constructed in this country.

Flywheel stored energy has been used extensively in such applications as steel rolling mills and cane sugar extraction plants, but in no case has a flywheel been built to supply energy for more than about a minute. Such applications as these involve attaching the flywheel directly to the output shaft so that as sudden loads occur and retard the driving motors the flywheel will release energy to the shaft.

A large scale flywheel energy storage plant, if financially justifiable, would have certain advantages over other conceivable systems. First, it would be independent of terrain and other geographical considerations influencing pumped storage, and could thus be located conveniently to existing power stations or load centers. Furthermore, the size of such a plant would be small compared to a pumped storage system. Its advantage over a system storing energy in the form of heated water or steam is that the flywheel energy is immediately available for use without the intervention of a prime mover (turbine or engine). The advantage over a storage battery system is that the flywheel element will not require so much maintenance and will not depreciate rapidly. Also, the power output capacity of the flywheel is essentially unlimited, while that of a battery has a definite maximum depending upon design and life considerations.

Let us investigate the energy storage capabilities of a flywheel system more closely: the maximum rotational speed of a flywheel will be limited by the strength of the material, which of course should be very high. It can be shown that the maximum stress in a rotating disc occurs at the inner radius of that disc and is given by the following formula:

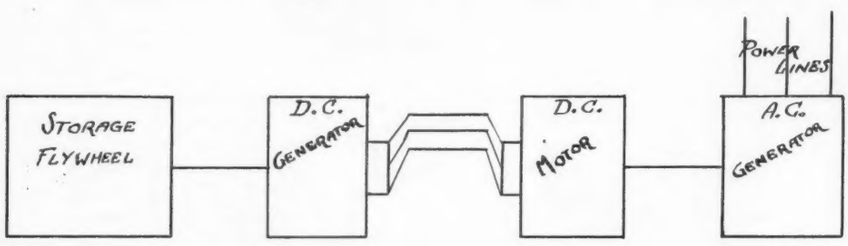


Figure 1. By passing the flywheel-stored energy first through a D. C. generator motor, constant-frequency A.C. generation is possible.

$$P_{max} = \frac{w}{32.2} \quad \frac{\omega^2}{4m} (3m + 1)R^2$$

R = Overall Radius
m = Poisson's Ratio = 4
ω = Angular Velocity
w = Weight per Unit Volume = 490, Pounds/Cubic Foot for Steel

The energy stored in a rotating cylinder is:

$$E = \frac{1}{2} I \omega^2$$

I = Moment of Inertia = $\frac{\pi l w}{2 \times 32.2} R^4$

ω = Angular Velocity
l = Length of Cylinder

The weight of a cylinder is:

$$W = \pi R^2 l w$$

R = Overall Radius
l = Overall Length
w = Weight per Unit Volume

From the above formula for maximum stress, we find:

$$\omega^2 R^2 = \frac{16}{13} \frac{P_{max}}{w/32.2}$$

Therefore the energy stored in a rotating cylinder is:

$$E = \frac{4}{13} \frac{P_{max} W}{w}$$

And the energy stored per unit weight is:

$$\frac{E}{W} = \frac{4}{13} \frac{P_{max}}{w}$$

Thus the energy stored in a rotating flywheel per pound of material is not dependent upon the size or shape of the flywheel, so long as the wheel is rotated at a speed sufficient to bring the maximum stress to the same value in each case.

Bethlehem Steel A-9255 can be quenched to a yield strength of 290,000 pounds per square inch. Let us assume that we will allow the maximum stress to reach 250,000 psi. a perfectly safe value since the maximum stress will occur at the center of the wheel. The steel will be relatively plastic, so the material at the center could probably be stressed to well above the yield point. The unit weight of steel is about 490 pounds per cubic foot. Using these figures we find that a flywheel can be built to store about 17 kilowatt hours per ton.

The total weight and speed of the flywheel will be determined by material availability, manufacturing considerations, and bearing capacity. With these considerations in mind, it is conceivable that a flywheel could be built as follows:

Shaft diameter	14 inches
Overall diameter	12 feet
Overall length	3.5 feet
Total weight	70 tons
Speed range	900 RPM to 2700 RPM
Usable energy before losses	1,000 kilowatt hours

Though roller bearings are used, the losses due to bearing friction alone are quite appreciable, being sufficient to reduce the speed of the coasting flywheel from 2700 r.p.m. to 900 r.p.m. in about two days. However, this particular assumption of flywheel size and bearing loss is not necessarily the best compromise, but merely serves to indicate the order of magnitude of friction losses in the flywheel.

The flywheel windage losses would be excessive if the flywheel were run in air, so to keep these losses to a level comparable to the bearing losses, the flywheel should be run in a high vacuum. This vacuum can be obtained by connecting the flywheel casing to the exhaust condensers of the associated turbines, where the pressure will be about 0.3 inches of mercury.

There are a number of possible ways of removing energy from the flywheel and converting it to electrical energy. The primary considerations besides cost are that the energy must be available at the voltage and frequency of the power lines, and that the power output and the power factor must be readily controllable and independent of the speed of the flywheel.

A very simple system for converting the flywheel energy to electrical energy would be similar to that shown in Figure 1. Here the flywheel delivers power to the D.C. generator, which furnishes power to a D.C. motor driving an A.C. generator. The A.C. generator puts power of the proper voltage and frequency into the line.

Another system involves the use of an induction generator, a frequency changer, and an A.C. motor as shown in Figure 2. The flywheel delivers power to the shaft of the induction generator, which pumps into the line an amount of power directly controlled by the amount of power being extracted from its slip rings by the frequency changer. The slip ring power is converted to the proper frequency by the frequency changer and fed to the A. C. motor which returns the power to the shaft. Thus the net power output of the flywheel to the line is controlled by adjustments to the frequency changer and motor.

Alternatively, the frequency changer shown in Figure 2 could have pumped the control power directly into the line through a transformer.

Still another possible method of extracting the flywheel power would be through the use of a Scherbius machine, a special form of variable frequency A.C. motor-generator, to take the slip ring power from the induction machine and convert it to usable energy.

The operation of the induction generator systems described above can be schematically represented as in Figure 3. In each case, the regulating machine, whether it be a frequency changer or a Scherbius

(*Continued on page 22*)

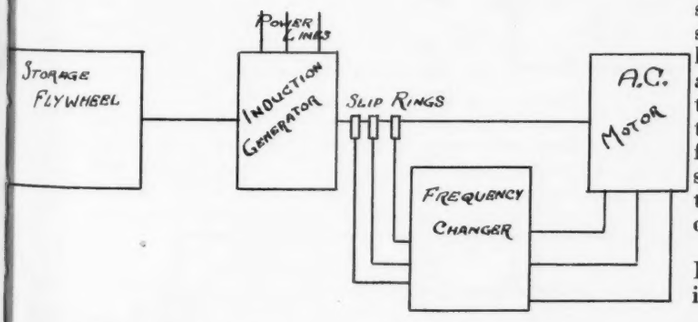


Figure 2. In this converter arrangement, the deceleration of the flywheel is compensated for by a frequency changer.

lightning quick

By Robert J. Horn, Jr., '48

Electronic Triggers for Flash Photography

Electronic flash units are now used in a wide variety of applications, ranging from studio and candid photography to analysis of the operation of high speed machinery. The picture accompanying this article is an example of the multi-flash technique in which a series of exposures of the same subject are recorded on one negative. This article will deal with some of the basic technical aspects of electronic flash units presented in an undergraduate Electrical Engineering thesis by the writer and Mr. Charles D. Losee. The thesis was done under the direction of Dr. Harold E. Edgerton, who pioneered the field and is responsible for much of the development work still being done.

The simplest electronic flash circuit is illustrated in Figure 1. A condenser is charged to a voltage above the ionizing potential of the flashtube and a relay is used to apply the voltage to the flashtube at the instant that firing is desired. The main advantages of this circuit are: safety can be increased since high voltage is applied through the cable to the flashtube only at the instant of firing; savings in weight and cost are effected due to the small number of parts; and synchronization is simple to apply to any camera since the time lag of the relay can be adjusted to equal the time lag of the camera as set for ordinary flashbulbs. The main disadvantages are that accurate synchronization depends upon two delay times being equal and that additional tubes cannot be fired in parallel (two tubes may, however, be fired in series).

The next type of circuit to be considered is shown in Figure 2. This type of circuit involves a flashtube with a trigger electrode. A trigger condenser C_2 is charged from the main power supply through a voltage divider. When the trip switch is closed this condenser discharges through a spark coil S to provide a high peaked voltage to the trig-electrode, firing the tube. This is the simplest circuit for triggering a flashtube. It has the advantages of a trigger-operated flashtube (e.g., paralleling tubes is easily accomplished and exact synchronization is more simply obtained since the timing does not depend upon the delay time of a relay), but there are still disadvantages inherent in the system. The voltages handled by the switch are fairly low, but the currents are sufficiently high to make the use of internal shutter contacts impractical. The voltage divider must be of a low enough resistance to allow the trigger condenser to charge up as soon as or before the main condenser to prepare for another firing. Although the resulting current drain on the output of the power supply is only in the order of a few milliamperes, it is appreciable when translated back to the batteries at low voltage.

The next step in the development of triggering methods appears in Figure 3. Here the circuit of Figure 2

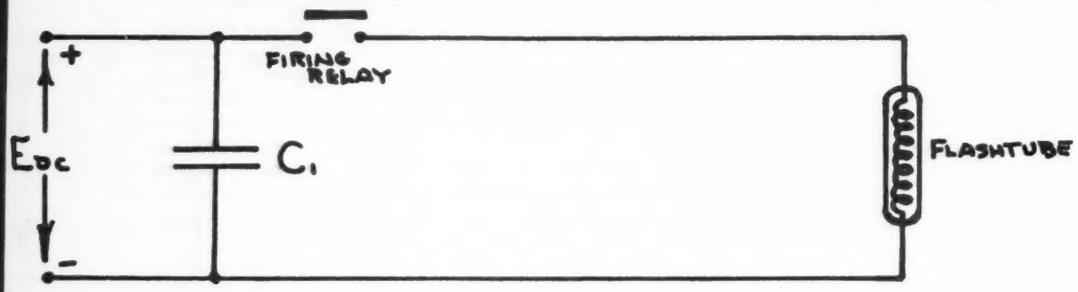


FIG. 1

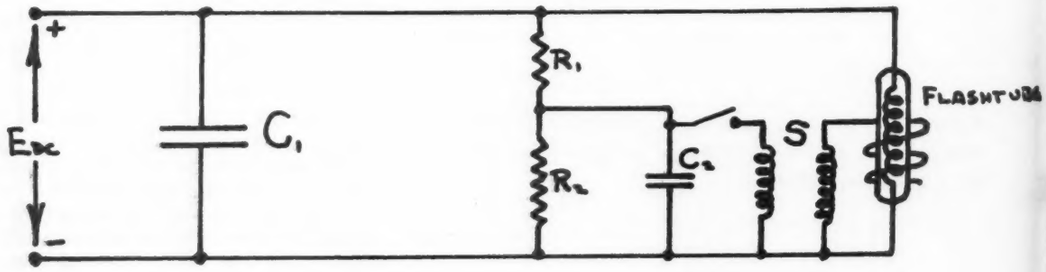


FIG. 2

is modified to include a cold cathode tube such as the OA4G. The triggering condenser C_2 is discharged through the trigger tube when the trip switch is closed to give the current surge through the primary of the spark coil necessary to trigger the flashtube. This method has the obvious advantage of limiting the current flow through the trip switch to the order of magnitude of microamperes. Thus shutter contacts can be used to trigger and automatically synchonize the flash at any shutter speed with no danger to the shutter or lens.

Although many more circuit refinements are available, in summary it can be said that some type of triggered tube is best for reasons of convenience and dependability. The most reliable method of shutter synchronization is with shutter contacts, which require some type of trigger tube system to limit the current handled by the contacts. Several cold cathode tubes are available: Strobotron SN-4 or 1D21 which will handle large peak currents; OA4G, a simple three electrode tube; and the OA5 which has low grid current and fast ionization time. Various circuits are used but they all involve the use of a condenser discharging through a spark coil to supply a trigger impulse. The leads of the spark coil should be as short as possible to preserve the sharpness of the trigger pulse and make the firing of the flashtube more accurate.

There are two major classifications of flashtubes — those which fire upon the application of the operating voltage, and those which must be ionized by a trigger electrode. Commercially available tubes of both types are normally filled with xenon, due to electrical characteristics and the fact that the color temperature obtained approximates that of daylight. Tubes which are used for special applications requiring extremely short flash durations also contain some hydrogen to reduce the de-ionization time. With the use of hydrogen, tubes may be flashed at rates up to about 1,000 flashes per second. Higher rates of flashing require electronic switching by means such as the use of capacitrons.

Tubes which fire upon the application of the operating voltage have lower gas pressures, since the firing potential increases with pressure. Efficiency also increases with pressure, so that relay operated tubes normally have lower efficiencies in the order of 25 lumens per watt. Since the relay tubes which are manufactured commercially are not normally constructed of pyrex or quartz, their power ratings are relatively small. Exceeding the rating will result in crazing the inner wall of the helix and will cause sputtering of the electrodes. The light output is considerably reduced by crazing and deposits from sputtering. The start-voltage limit on most relay type tubes is relatively low, since the basing-pin separation is not great. The tubes may start more easily when the electrode within the helix is used as the cathode if the tube has an open end helix, but the life of the tube is greatest

This multiflash picture, of a type which has now become familiar to magazine readers, was taken by Dr. Harold E. Edgerton.

if the outer electrode (the one to which the getter is attached) is used as cathode.

To summarize, flashtube efficiency tends to increase with pressure, loading, and voltage. Damage to the tube provides a limiting point for loading; the limiting point may be extended by the use of pyrex or quartz. Although quartz enables one to obtain the highest efficiencies, the cost of construction is very high.

There are two general types of condensers that may be used for energy storage in stroboscopic flash units: oil-filled or paper condensers and electrolytic condensers. Since the weight of the capacitor in a flash unit is such a large part of the total weight (about one-half in a portable unit), a consideration of the weights of commercially available units in conjunction with their ability to produce light is very important. In general, oil-filled condensers have high efficiencies, but they also have high weights. The exact opposite is true of electrolytic condensers. Electrolytic condensers have much higher leakage currents, and are less dependable, even if the comparison is made with the over-rated oil-filled condensers often used in flash units. The overall advantages of oil-filled condensers may be increased in the near future as a result of work done

(*Continued on page 38*)

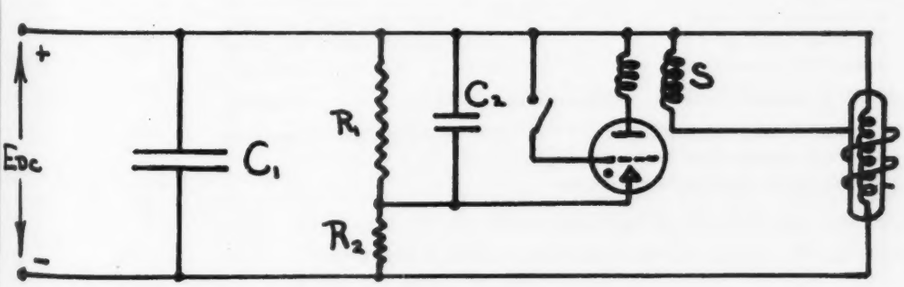


FIG. 3

the tech engineering news

Professional Journal of the Undergraduates of the
Massachusetts Institute of Technology

Managing Board

EDWARD T. MILLER, '49 . . . . . General Manager
KENNETH D. KOPPLE, '51 . . . . . Editor-in-Chief
RALPH C. JOHNSTON, '50 . . . . . Managing Editor
HELMUT E. WEBER, '50 . . . . . Business Manager

Junior Board

LOUIS GALAN, '51 . . . . . Advertising Manager
ROY W. JENKINS, '50 . . . . . Make-Up Editor
CHARLES M. JORDAN, '49 . . . . . Art Editor
GEORGE B. FIELD, '51 . . . . . Literary Associate
ROBERT N. RANDALL, '50 . . . . . Circulation Manager

Staff

MILO M. BACKUS, '52
FRED BERGMANN, '50
ALEX BLOCH, '50
DAVE CAPLAN, '51
FRED DIAMOND, '50
BOB DONOVAN, '52
MARTIN M. FINK, '52
KEN KING, JR., '52
NATHAN KIRSHBAUM, '51
JERRY LEVINE, '51
BILL LUCAS, '51
JACK RAVECH, '51
MADGE ROSENBAUM, '51
CHARLES M. SALTSMAN, '52
GEORGE SCOLEDES, '52
MYLES SPECTOR, '50
WALTER STAHL, '51
JOHN G. STEVENSON, '49
DAN SULLY, '51
PAUL WESTHEIMER, '52

Member Engineering College Magazines Associated

ARKANSAS ENGINEER
CINCINNATI COOPERATE ENGINEER
COLORADO ENGINEER
CORNELL ENGINEER
DREXEL TECHNICAL JOURNAL
ILLINOIS TECHNOGRAPH
IOWA ENGINEER
IOWA TRANSIT
KANSAS ENGINEER
KANSAS STATE ENGINEER
KENTUCKY ENGINEER
MARQUETTE ENGINEER
MICHIGAN TECHNIC
MINNESOTA TECHNO-LOG
MISSOURI SHAMROCK
NEBRASKA BLUEPRINT
NEW YORK UNIVERSITY QUADRANGLE
NORTH DAKOTA ENGINEER
OHIO STATE ENGINEER
OKLAHOMA STATE ENGINEER
PENNSYLVANIA TRIANGLE
PENN STATE ENGINEER
PURDUE ENGINEER
ROCHESTER INDICATOR
ROSE TECHNIC
TECH ENGINEERING NEWS
WAYNE UNIVERSITY ENGINEER
WISCONSIN ENGINEER

JOHN A. HENRY, University of Illinois, Urbana, Illinois — Chairman

LITTELL MURRAY BARNHILL, INC. — Publisher's Representative
101 Park Avenue, New York
605 North Michigan Avenue, Chicago

from the editor's notebook

We ramble on . . .

Something here needs fixing. Members, at M. I. T., of Courses V, VIII, IX, XII, XVIII, and XX are not eligible for admission to either Tau Beta Pi or Phi Beta Kappa, the two largest national honorary scholastic fraternities. There is, of course, no chapter of the latter at Tech, where engineering reigns supreme; while the national constitution of Tau Beta Pi states that courses whose students are to be eligible for membership must be administered by the Dean of Engineering. Such courses as chemistry, physics, and food technology here do not fall into this category, but these fields, especially as taught at M. I. T. are very much akin to engineering. For that matter, in schools where such fields do fall under the engineering administration, their students are admitted to Tau Beta Pi. It would appear that here is a technicality which should be straightened out.

Probably everyone at Tech has heard of or taken part in the instructor evaluation polls. The initiation of these polls was due to Tau Beta Pi, although departmental honorary societies are taking up the task. Tau Beta Pi has compiled data to indicate the worth of such polls. It has been found that those who have been teaching for less than eight years take the poll's results quite seriously and act on them. Those with experience up to fifteen years vary in their response, while almost no effect is had upon those teaching for more than that time.

and on . . .

Perhaps you noticed something different in this issue — something to do with the contents, not the appearance, of the magazine. There is such a difference this time: all articles except one were written by members of Tau Beta Pi especially for the Tech Engineering News. The exception is a five-hundred-word Tau Beta Pi initiation paper, quite apropos in the vicinity, which was tossed in as dressing.

A national honorary engineering society, Tau Beta Pi comprises at Tech about one hundred active members of the approximately two hundred and fifty eligible in the top eighth of the junior class and top fifth of the senior class. Membership is not based on pure scholarship — we have it that admission is largely determined by outside activities. Scholarship, Character, Breadth of Interest, and Practicality are the formal requirements.

Because Phi Beta Kappa membership was and is restricted to Liberal Arts students, Tau Beta Pi was founded some seventy years ago at Lehigh. The familiar key worn by its members has become as important a symbol of recognition as that of the Liberal Arts society.

We would like to call your attention to "Whirling Weights," and state that it was written in all due seriousness. So far as we are concerned, however, we would hate to be anywhere around if a seventy-ton flywheel got loose.

It seems correct to us that the honorary engineering society here should sponsor an issue of *T. E. N.* We would like to express our thanks for the co-operation received in meeting our deadlines and copy specifications. We received more aid in that line than we often get from our own staff.

K. K.

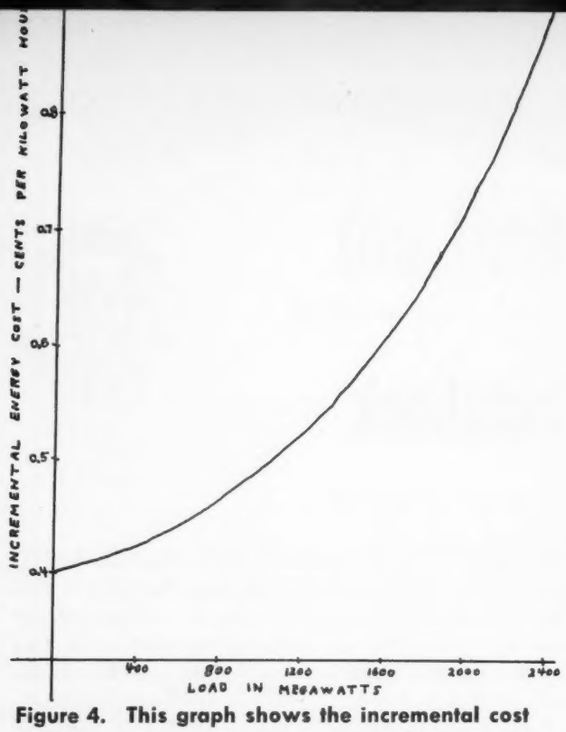


Figure 4. This graph shows the incremental cost of electric energy as power demands increase. The sharp increase per unit at higher levels is due to use of inefficient machinery under peak loads.

the whirling weight

(*Continued from page 17*)

machine, controls the power output by means of operating on a small fraction of the total and then either returning that fraction to the line, as in (A), or to the shaft of the flywheel as in (B). The only loss is that due to the inefficiency of the regulating machines.

There are three justifications for the construction of an energy storage plant in connection with existing facilities. First, we could balance the worth of a storage system as a substitute for new generating equipment required because of load growth against the cost of providing that storage system. Typical of power plants whose demand is increasing is the Consolidated Edison System of New York. It furnished about 100 megawatt hours per day in 1948 at demand greater than corresponding peak demands in 1947. This load growth could be met by a flywheel storage system, storing energy when loads are small and discharging in peak periods; the size of the storage system would naturally be determined by the additional power needs of the plant at peak load.

If a new generating plant of sufficient capacity to service the load increase from 1947 to 1948 had been built, it would have cost about $200.00 per kilowatt or a total of $20 million. However, this equipment would probably have been used for much of the day, so the net capital cost of furnishing the new service would have been considerably less than the purchase price of the new equipment. It will not be necessary to calculate this charge here, but it seems likely that a storage system with sufficient capacity to carry the 1947-1948 load increase might have been justifiable if its price were no more than say $8 million.

(*Continued on page 26*)

FACTS ABOUT SKF

The Self-Aligning Bearing Was Invented In 1907!

Back in 1907, SKF invented the self-aligning ball bearing—the bearing that revolutionized industry by compensating for shaft deflections, distortions or weave. In 1920, SKF also invented the spherical roller bearing that has the characteristics of the self-aligning ball bearing, but is designed to absorb much heavier loads. 6595

SKF INDUSTRIES, INC., PHILA. 32, PA.

SKF
BALL & ROLLER BEARINGS

When plans to deepen the Kill Van Kull channel in New York harbor were announced, telephone engineers had to plan a new submarine crossing for the important New York-Philadelphia long distance route.

There were many problems. How far below the floor of the new channel should cables be placed? How could a trench be opened through tons of mud and shelves of rock? In the fast-flowing tides, how could cables be laid squarely in the bottom of the trench? How many circuits, what kind of cables, what size, and how many should be provided for future needs? These questions demanded, and got, many engineering skills.

Despite obstacles, the job was completed on schedule. Eighteen new cables, capable of carrying 5,600 simultaneous conversations, are entrenched safely between Staten Island, N. Y., and Bayonne, N. J.

It's another example of telephone engineering at work.

BELL TELEPHONE SYSTEM

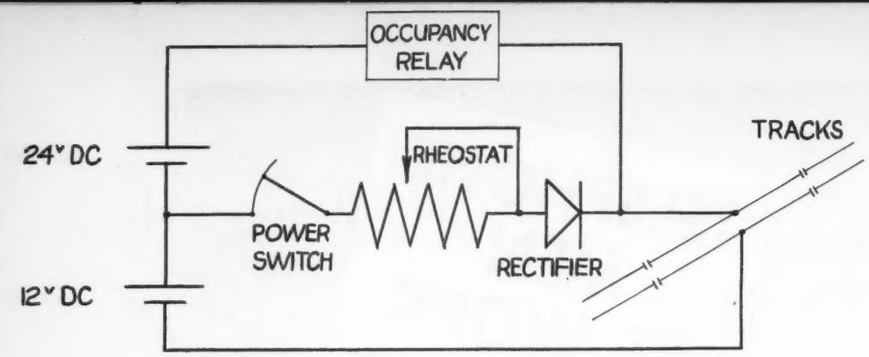


FIG. 4(A)

mainline

(*Continued from page 10*)

reduce the size of the power supply unit and its standby capacity, an impulse-operated switch machine was developed. In order not to tax the limited direct current supply, 24 V./A.C. is used. A standard bat-handle d. p. d. t. switch is used to produce a definite throw to act as an automatic locking device, and to provide switch contacts. These contacts are used for impulse operation of the switch machine regardless of the length of time which the operator might take to throw his control knob, and for automatic transfer of power across the turnout, thus eliminating the possibility of train stoppage on the turnout because of uncertain electric contacts. Finally, lamps to indicate switch position are included. The circuit is shown in Figure 4b.

To operate all the equipment described, the power supply has been built to handle over a kilowatt of power. Actually, for full operation, present estimates point to a use of up to 400 million microwatts. This will be supplied by two step-down transformers, batteries, and rectifiers, converting the 110 V./A.C. line supply to 24 V./A.C., 24 V./D.C., and 12/V.D.C. Adequate metering and protective devices have been installed.

Every effort is made to operate the layout as realistically as possible, with operation by timetable as the ultimate refinement. All the trains operated in real life have their model counterparts — passenger trains of all types, long through freights, slow local freights, special milk, cattle, or ore trains, and, of course, the vitally needed switching locomotives. Each train is run in accordance with prototype procedure. In order to send a passenger train onto the mainline, a string of coaches or Pullmans will be pulled from the yards, tracks (15) or (16), by a switching locomotive, coupled into one train on (17), pushed into a platform track (18), (19), or (20), and uncoupled from the switcher. A road locomotive runs from the engine house — over (26), (5), and (25), and couples onto the waiting train. It then enters the mainline (14) and makes its way over the layout in accordance with its given schedule. Since it is first class, i.e., it has a schedule to maintain, the passenger train has priority on the mainline at all times and, therefore, needs to have no worry about meeting other trains; all others must clear the track whenever the passenger train is due. Having traversed the layout and having made specific stops, it then returns to the terminal where the road engine uncouples and runs down to the engine house. The switcher then pulls the coaches into the makeup track (17) and breaks it up by placing the

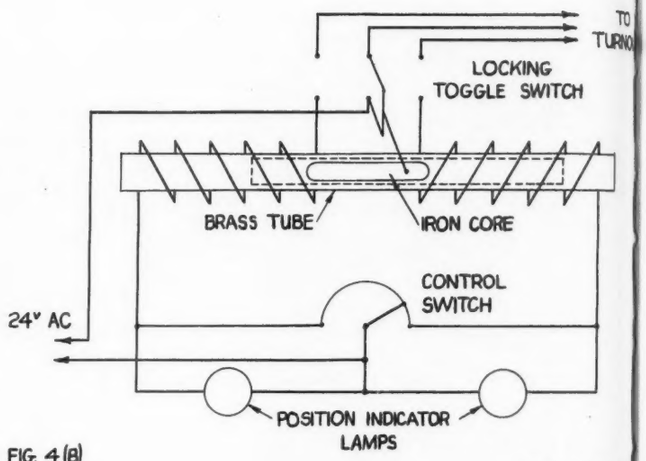


FIG. 4(B)

3-22-49 R.D.

cars into the storage tracks. At the same time, it is likely that another train is leaving the terminal under a different engineer.

Passenger train operation is the simplest used, for it involves only assembly of equipment and going over the layout. Freight train operation is more complex since freights traverse the mainline only when they have an opening between scheduled passenger trains, and in addition have the task of switching cars into and out of industrial sidings along the right-of-way in accordance with their train orders. The handling of such freight is the hardest and, at the same time, most rewarding operational job, because of the skill and good judgment necessary to avoid fouling the mainline. The locomotive must accomplish the switching movements in the shortest time possible, but at the same time it must be in a siding off the mainline whenever the passenger train is due. Prudence is necessary where an estimate and a decision must be made as to the feasibility of an attempt to reach the next siding a mile or so up the line, before the higher priority train rolls past.

The operational realism is enhanced by adhering strictly to scale speed. The T. M. R. C., because of comparatively tight curves (265 scale foot minimum radius), will keep its mainline speed to 50 miles per hour, and yard speeds to 20 miles per hour in order to achieve trouble-free operation. Jackrabbit starts and lightning dashes are not permitted, even in the midst of operational excitement. The threatened delay of a

(*Continued on page 28*)

Massachusetts Institute of Technology
CAMBRIDGE, MASSACHUSETTS

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY
offers the following Professional Courses

SCHOOL OF ARCHITECTURE AND PLANNING

Architecture

City Planning

SCHOOL OF SCIENCE

Chemistry
Food Technology
Food Technology — Five Year Course
General Science
Geology
Mathematics
  Options: Pure and Applied Mathematics
           Industrial Statistics
Physical Biology
Physics
Quantitative Biology

SCHOOL OF ENGINEERING

Aeronautical Engineering

Building Engineering and Construction
  Options: Heavy Construction
           Light Construction

Business and Engineering Administration
  Courses: Based on Physical Sciences
           Based on Chemical Sciences

Chemical Engineering

Chemical Engineering Practice

Civil Engineering
  Group Electives:
    Sanitary Engineering
    Transportation Engineering
    Hydraulic Engineering
    General Engineering

Economics and Engineering
  Options: Human Relations
           Industrial Relations

Electrical Engineering
  Options: Electric Power
           Illumination Engineering
           Electrical Communications
           Electronic Applications

Electrical Engineering
  Co-operative Course

General Engineering

Marine Transportation

Mechanical Engineering
  Options: General Mechanical Engineering
           Engineering Science
           Automotive Engineering

Mechanical Engineering-
  Co-operative Course

Metallurgy
  Options: Metallurgy
           Mineral Dressing

Meteorology

Naval Architecture and Marine Engineering

The duration of each of the above undergraduate Courses is four academic years, with the exception of Architecture, Food Technology (Five Year Course), Physical Biology, and the Co-operative Courses in Electrical Engineering and in Mechanical Engineering, which extend over a period of five years. In addition to the Bachelor's degree, the above five year courses, with the exception of Architecture, lead also to the Master's degree.

Graduate study, leading to the Master's and Doctor's degrees, is offered in Ceramics and in most of the above professional Courses.

A five year Course is offered which combines study in Engineering or Science, and Economics. This leads to the degree of Bachelor of Science in the professional field, and to the degree of Master of Science in Economics and Engineering or Economics and Natural Science.

For information about admission, communicate with the Director of Admissions. The Catalogue for the academic year will be sent free on request.

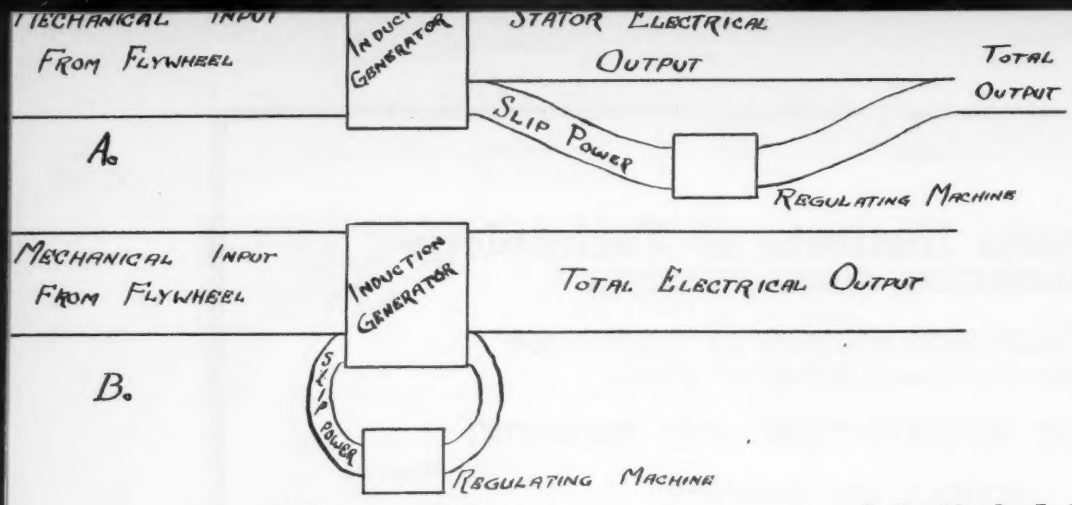


Figure 3. Two methods for controlling the power output of an induction generator. In (A) the slip power is converted by the regulating machine to the proper voltage and frequency, while in (B) the slip power is returned in mechanical form to the shaft of the induction generator.

the whirling weight

(*Continued from page 22*)

Another very important possibility for justifying the installation of storage system in connection with a central station derives from the savings which would result if the energy generated by old and inefficient equipment during peak demand periods were replaced by lower cost energy, generated during off-peak hours by otherwise unused high efficiency equipment and stored until needed. The curve of incremental fuel cost per kilowatt hour of electrical energy sold by the Consolidated Edison Company of New York as a function of the power demand in megawatts is shown in Figure 4. The curve rises rather steeply as the load increases and old generating equipment is put on the line. Figure 5 reveals that a considerable fraction of the energy sold by the Edison Company is produced at a relatively high cost, but high efficiency equipment must be shut down many hours each day because of lack of load. It is obvious that savings would result if a larger fraction of the total energy could be furnished by the high efficiency machines through a storage system.

A third possibility of justifying the purchase of an energy storage system arises in the case of an industrial power customer whose plant is running less than twenty-four hours per day. All industrial power contracts provide for one charge based upon the actual energy used and another charge, called "demand" charge, which is dependent upon the maximum power used at any time during the billing period. Any expedient which tends to reduce demand is thus a potential money saver.

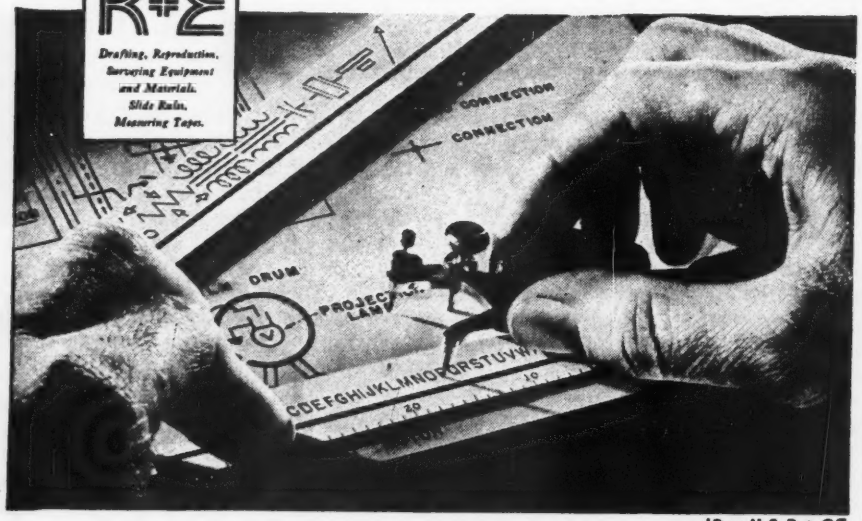
An illustration of this point is as follows: In 1947, a customer of Consolidated Edison who used a steady 1,000 kilowatts of electric power eight hours per day, twenty days per month would have been charged about $1,600 per month for the energy he used and about $1,400 per month for his 1,000 kilowatts of demand. If the customer were to install a storage system which would take up energy from the line at a constant rate during the non-working hours and release it during the eight working hours, the demand would be reduced to one third its normal value, thus reducing the demand charge by $900 per month or $10,800 per year. It is thus possible that such a manufacturer could justify the expenditure of about $100,000 for an energy storage system with a capacity of about 6,000 kilowatt hours and a rated output of 700 kilowatts.

The above discussion points out some of the possibilities of flywheel storage of energy, though the actual calculations preliminary to the initiation of such a radical project would take many times the space of this article.

However, it seems that engineers will soon find it necessary to develop some practical method of energy storage applicable to central generating stations, since the present trend toward electric heating and the use of such devices as the "heat pump" means that the peak loads of power systems will become more pronounced, with a consequent decrease in the effective usage of boiler, turbine, and generating equipment unless energy storage is provided.

partners in creating

For 81 years, leaders of the engineering profession have made K & E products their partners in creating the technical achievements of our age. K & E instruments, drafting equipment and materials—such as the LEROY† Lettering equipment in the picture—have thus played a part in virtually every great engineering project in America.



†Reg. U.S. Pat. Off.

KEUFFEL & ESSER CO.

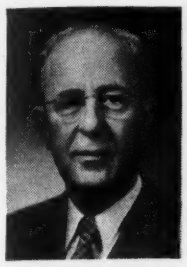
EST. 1867

NEW YORK • HOBOKEN, N. J.
Chicago • St. Louis • Detroit
San Francisco • Los Angeles • Montreal

Get a Close-Up OF THE BASIC INDUSTRY OF YOUR CHOICE!

by R. S. FLESHIEM
Manager Electrical Department
ALLIS-CHALMERS MANUFACTURING CO.
(*Graduate Training Course—1904*)

WHEN YOU GET into daily working contact with an industry, you may find it offers specialized opportunites that you hadn't known about before. That's why it's not always possible—or wise—to pick *your* final spot in industry until you've had some all around first-hand experience.



R. S. FLESHIEM

I want to suggest a good way to *get* a close-up of the industries that appeal to you.

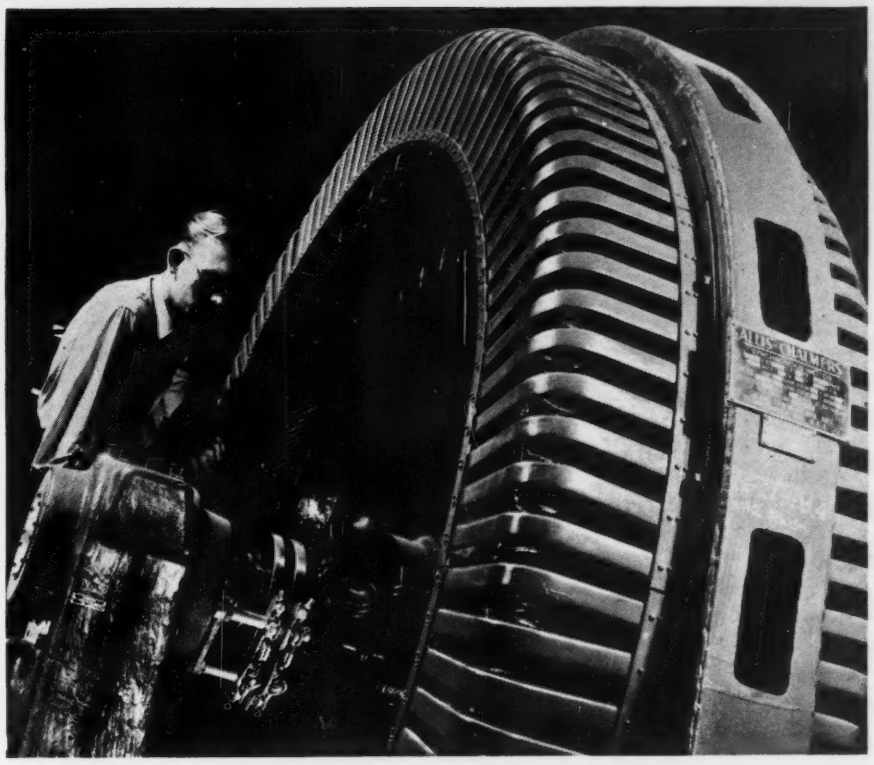
Naturally, I can talk with most assurance about the electric power industry. But the same principles apply to others.

When I got my engineering degree from the University of Michigan, the electric power industry was a fast-growing youngster. I decided to go to Allis-Chalmers, where I joined the company's first Graduate Training Course in 1904. I was sent to Cincinnati and started in the old Bullock Electric Mfg. Co. plant that Allis-Chalmers had purchased that same year. Bullock, incidentally, started in 1884—one of the real old-timers in the electric industry. It was the start of the present Allis-Chalmers Electrical Department.

Opportunities Are Increasing

The industry was growing fast at the turn of the century, but it's growing even faster now. Opportunities were never greater—or more varied.

Studying power and capacity factors in ore crushing, in Allis-Chalmers' complete basic industries laboratory. Camera-recorded data will be applied to commercial mining operations.



Inside View of a big synchronous motor. A-C Graduate Training Course students may follow important electric power equipment from blueprint to installation.

Today we have Graduate Training Course engineers applying their ability and training to the problems of machine design—research and development—manufacturing and production—sales—application engineering. Here we're working with electric power generation, control and utilization—with advanced industrial uses of electronics—with research in D. C. transmission. We're in intimate touch with the electric power industries—with transportation—with steel, metal working and other big power users. And I know that the field is just as broad in the other major industry departments here at Allis-Chalmers.

What Industry Interests You?

I firmly believe that Graduate Training Course engineers have a unique opportunity at Allis-Chalmers. They have the opportunity here to explore thoroughly not one, but many basic industries if they choose. This company produces the world's widest range of major industrial equipment, and every department is open to the graduate engineer. That includes electric power, mining and ore reduction, cement making, public works, steam turbines, pulp and wood processing. It also includes the full range of activities within each industry: design, manufacturing, sales, research, application, advertising.

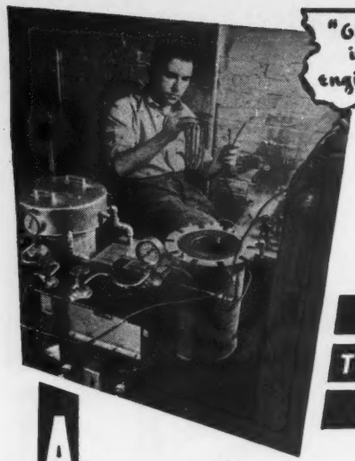
Graduate students help plan their own courses at Allis-Chalmers, and they move around a good deal. It's possible for a man to come here with the idea of designing electrical equipment—later become interested in manufacturing—and finally find his greatest satisfaction and success in sales work. Men move from department to department, getting a practical working knowledge of each. And—the departments get to know the men. Opportunities present themselves according to ability.

At the completion of the Graduate Training Course, you've had a close-up of many industries. You're ready to take your place in the work of your choice.

Write for details of the Allis-Chalmers Graduate Training Course—requirements, salary, advantages. Representatives may visit your school. Watch for date.

Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin

ALLIS-CHALMERS



A BOMB THAT DESTROYS GUESSWORK

ACCELERATED aging tests are part of the Okonite product improvement program. While they cannot replace the study of actual exposure to weather in proving ground and in the field, they have a definite place in estimating the value of electrical insulation.

The oxygen bomb shown at the left is used in accelerated aging tests — one piece of apparatus among many other examples of modern equipment at the service of Okonite engineers and technicians in taking the guesswork out of the manufacture of insulated wires and cables. The Okonite Company, Passaic, New Jersey.

OKONITE SINCE 1878 5237

insulated wires and cables

Jumbo Shrimp . . . 50,000 Pounds a Day

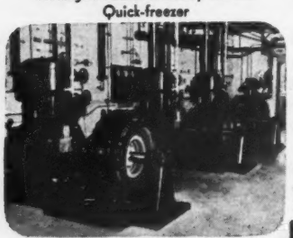
Quick-frozen with **Frick Refrigeration**

Packaged Seafood Ready for the Quick-freezer

Nearly five hundred Mississippi fishing boats are given a dual service by the Biloxi Freezing Co. Here, in the heart of the famous Gulf Coast resort, the boats are each loaded with from 6 to 18 tons of ice before sailing. Their freshly caught shrimp and other seafoods are then quick-frozen at the same busy plant, now in its second season.

This is another example of what Frick ice-making, refrigerating and air conditioning equipment can mean to new industries—and to old. Let us quote on your cooling needs.

The Frick Graduate Training Course in Refrigeration and Air Conditioning, operated over 30 years, Offers a Career in a Growing Industry.



Four of the Five Frick Refrigerating Machines at Biloxi

DEPENDABLE REFRIGERATION SINCE 1853

FRICK CO.

WAYNESBORO, PENNA. U.S.A.

mainline

(*Continued from page 24*)

through train by bad judgment will not justify a 150 mile per hour race to the nearest passing siding.

Timetable operation would be all but impossible without automatic coupling and uncoupling. The Club has standardized on a commercial coupler that approximates scale appearance, couples easily and consistently, and uncouples by means of an inconspicuous track side ramp. Experience has indicated that this coupler is by far the most dependable on the market, and with it the making, breaking, and switching of trains can take place with the operator remaining at the control board.

The yards, of course, are the focal point of activity. The schedule will call for the departure or arrival of trains every few minutes. The trains must be made up completely before the big road locomotives leave the round house and couple onto them. Cars are not shifted haphazardly, but rather in accordance with train orders and prototype practice. A local freight, for instance, is made up of cars that the superintendent has previously scheduled for delivery to various industrial sidings and in the order of delivery to these sidings. The freight yards have space for the storage of over sixty cars, and the designated ones must be picked up by the switcher and spotted into its own place in the train. When a train arrives in the yards, the switcher pulls the train apart, and either adds some of the cars to another waiting train or stores them in the yard. All these moves are accomplished without the operator's touching the train, promptly and realistically so as to avoid any delay whatever.

An additional feature of the Club's operation is that the mainline engineers have no control over the mainline switches; these switches are controlled from a central panel apart from the engineer panels. The switchman throws the switches according to his train schedule; the engineer, checking with the switch indication on the large display board, simply proceeds over his route. This system is in accordance with prototype practice.

The layout has been designed to utilize several men in its full operation. There are two control panels for mainline operation, one panel for the freight yard, one for the passenger yard and terminal, one for the engine house and turntable facilities, and finally the mainline switch panel. Hence six men are required to put all panels into operation.

In actual timetable operation, however, even more men are expected to be used. Their functions are to co-ordinate rather than operate, but they are essential to the smooth performance desired. Each man's job has its real railroad prototype. The superintendent is responsible for making out a train schedule, the dispatcher checks the adherence to the schedule and revises it if necessary, and various tower men and dispatcher's assistants aid the dispatcher by reporting arrival and departure times of trains at various points and by communicating order revisions to the engineers. This aid is vitally necessary since under as crowded a schedule as the Tech Club is designed for, no one man could possibly keep track of five trains simultaneously, and in addition make revisions of train orders to minimize the disruption caused by accidents or delays. The dispatcher must quickly interpret standard forms passed to him by the tower man in order to keep a running picture of developments; his job is one of feverish paperwork.

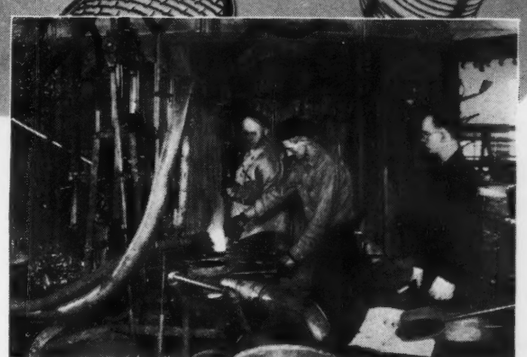
Modern Techniques Employed by KOPP GLASS, INC. Illustrate Effective Utilization of GAS

ENGINEERED GLASS—produced for signal, technical, and industrial purposes—involves small-batch operations and specialized glass-making practices. At Kopp Glass, Inc., Swissvale, Pa. engineers have applied modern production machinery to these highly technical processes, utilizing flexible GAS for all heating requirements.

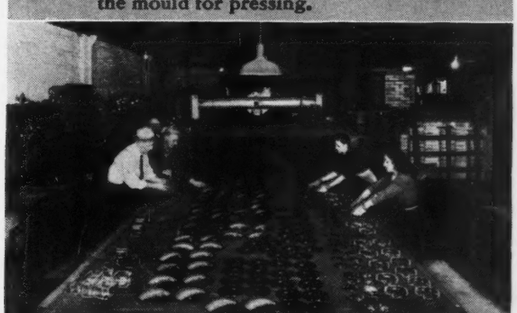
As large users of fuel, Kopp executives are concerned with the operating economies made possible by effective utilization of GAS in modern Gas-fired Equipment. But equally important is the automatic controllability of GAS for the varying temperatures used for melting, annealing, tempering, mould heating, in this specialized glass business. The importance of GAS in the Kopp plants is stressed by the wide range of equipment using this efficient fuel—

- **2 pot-type regenerative furnaces**
- **2 special heat treating lehrs**
- **grinding and polishing plate heaters**
- **4 day tank furnaces**
- **3 annealing lehrs**
- **1 mould oven**
- **2 pot arches**
- **2 ring ovens**
- **1 cut-off machine**
- **1 trial-pot furnace**

In commenting on the use of GAS for heat-processing in the manufacture of engineered glass, supervisor



Molten glass from the Gas-fired regenerative furnace (rear) is placed in the mould for pressing.

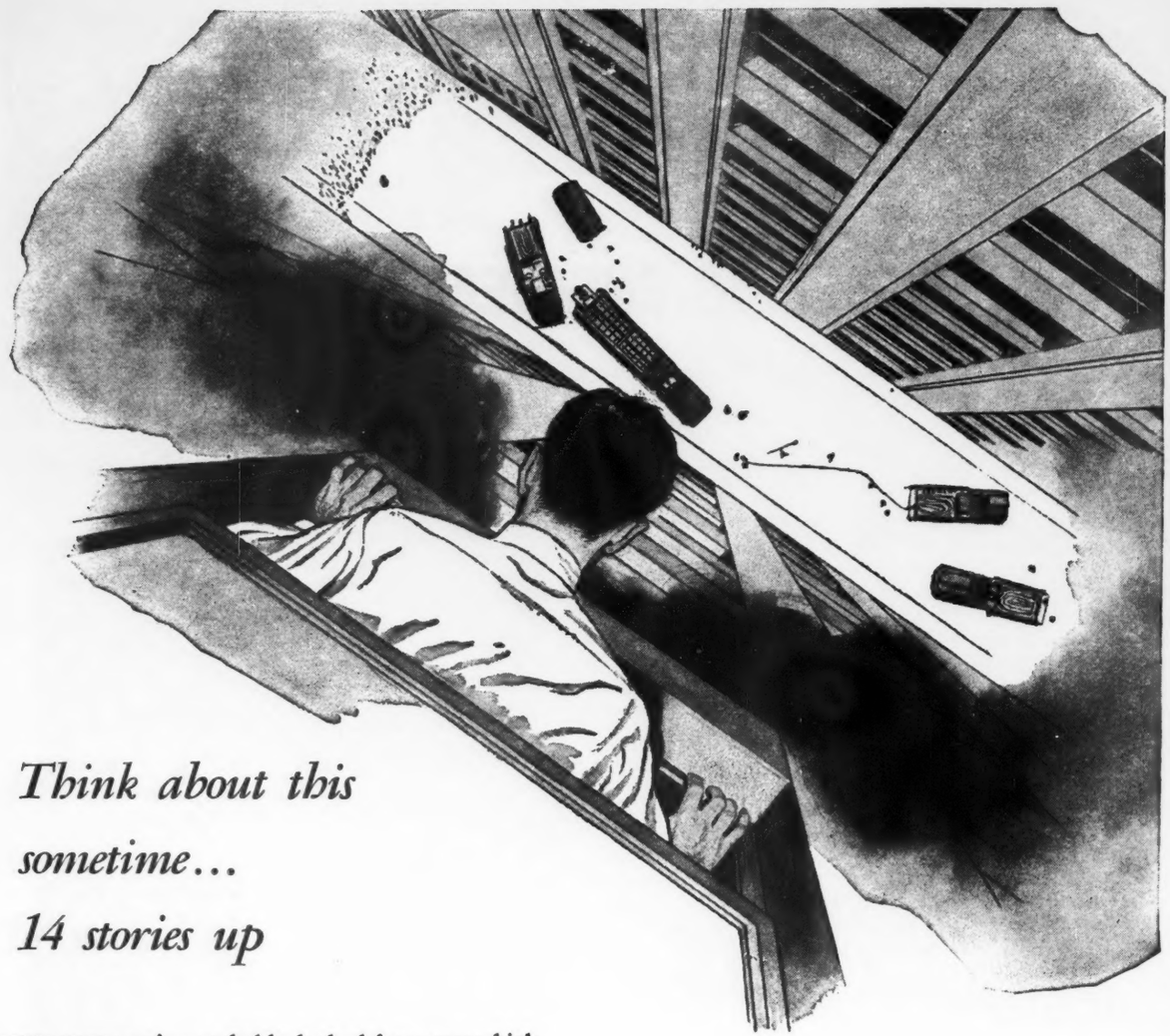


Continuous Lehr in which GAS is used for annealing signal and industrial glass products.

of Equipment J. B. Fullen says, **"The automatic controllability and the speed of GAS are of great importance, but we can't overlook the cost of fuel in our type of operation. That's why we use every device for effective utilization of GAS."**

You'll find it worthwhile to investigate modern Gas Equipment for heat-processing in glass manufacturing.

AMERICAN GAS ASSOCIATION
420 LEXINGTON AVENUE, NEW YORK 17, N.Y.



Think about this sometime... 14 stories up

IN THE PAST you've probably looked from some high window, and wondered what would happen if you were trapped by fire. But the chances are you never thought it could really happen to *you!*

But it *could* and *might* happen to you. And here's how.

Granted that your favorite hotel is made of steel and concrete and it will not burn. It is "fireproof". But its contents *are not.* It is like a furnace, with fuel at the bottom—perhaps flammable wastes and stored goods of all kinds in the basement. And like a furnace, when ignited, the flame is at the bottom, but the heat goes to the top. Red hot gases surge through elevator shafts, vents and passageways, carrying destruction upward.

◇ ◇ ◇ ◇

YES, IT CAN HAPPEN TO YOU, or anyone, for as long as people are human and careless, there is no way to prevent such fires from *starting* . . .

But such fires can be *controlled.* Needless destruction and loss of life can be *prevented* by checking fire at the source, when it starts, with Grinnell Automatic Sprinkler Systems. Seventy years experience show that close to 100% of fires starting in buildings protected by Grinnell Sprinkler Systems are extinguished before doing material damage.

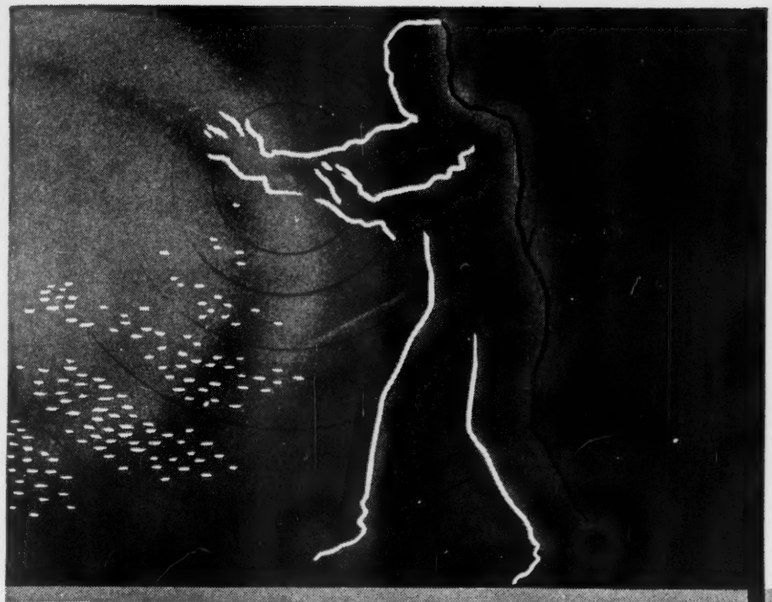
LOOK FOR THE GRINNELL SPRINKLER HEAD ON GUARD!

In hotels, schools, hospitals, theatres and factories, there is a moral obligation upon management for the utmost in protection of life and property. For your own sake ask about it in the hotel where you stop, the plant in which you work, the school your youngsters attend. Everywhere you go, look for famous Grinnell Automatic Sprinkler heads—your assurance of fire protection. Grinnell Company, Inc., Providence, Rhode Island.

GRINNELL

AUTOMATIC FIRE PROTECTION SYSTEMS

ENGINEERING GRADUATES HAVE FOUND ATTRACTIVE OPPORTUNITIES WITH GRINNELL



Blind man's buff

Blind man's buff is an expensive game to play with alloy steels. It is safer to go directly to the steel that will give the best performance at the lowest cost per finished part.

Molybdenum steels have shown time and again that they will provide consistently good properties at surprisingly low cost. Even their impact strength is consistent because they are not temper brittle.

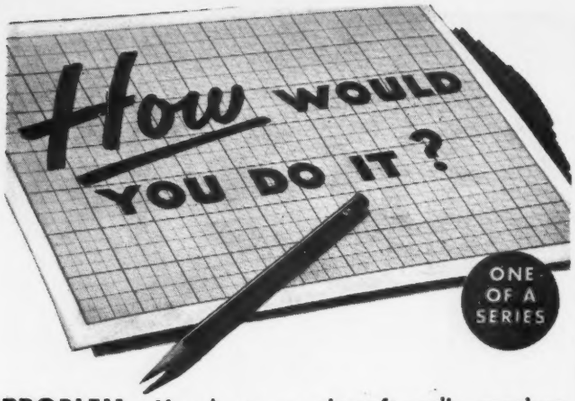
Send for our comprehensive 400-page book, free; "MOLYBDENUM: STEELS, IRONS, ALLOYS."

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS

Climax Molybdenum Company
500 Fifth Avenue · New York City

MOLY

C3

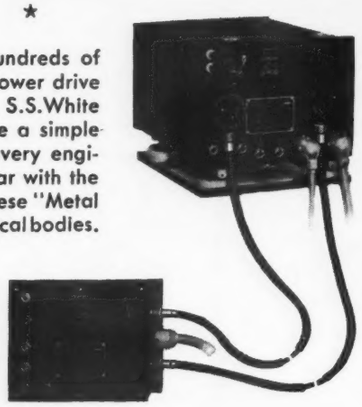


PROBLEM—You have an aircraft radio receiver. To operate it, the band selector and tuning elements must be adjusted. You want to arrange it so that these adjustments can be made right at the receiver or from a remote point. How would you do it?

THE SIMPLE ANSWER—Use S.S.White remote control flexible shafts to connect the tuning dials on the receiver to tuning cranks on a remote control unit. This arrangement leaves you free to mount the control unit anywhere you want, and assures you of smooth, sensitive tuning from any distance up to 50 feet or more. The shafts can be readily run around turns, along walls, under flooring as conditions in different aircraft may require. Any required degree of sensitivity can be obtained by connecting the shaft through simple gearing.

★ ★ ★

This is just one of hundreds of remote control and power drive problems to which S.S.White flexible shafts provide a simple answer. That's why every engineer should be familiar with the range and scope of these "Metal Muscles"* for mechanical bodies.



Here's how one large manufacturer provided an answer to this problem.

WRITE FOR BULLETIN 4501

It gives essential facts and engineering data about flexible shafts and their application. A copy is yours free for asking. Write today.

*Trademark Reg. U. S. Pat. Off. and elsewhere

S.S.WHITE INDUSTRIAL DIVISION

THE S. S. WHITE DENTAL MFG. CO. DEPT. C, 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS • FLEXIBLE SHAFT TOOLS • AIRCRAFT ACCESSORIES
SMALL CUTTING AND GRINDING TOOLS • SPECIAL FORMULA RUBBERS
MOLDED RESISTORS • PLASTIC SPECIALTIES • CONTRACT PLASTICS MOLDING

One of America's AAAA Industrial Enterprises

co-operative education in action

(*Continued from page 8*)

nition and development of a few all important key men and by more accurate screening and placement of general professional personnel.

The returns to industry on investment in co-operative education cannot be measured in dollars and cents, but these returns are none the less very real. As it becomes increasingly evident that the machine is limited but by man, progressive managements are attaching more and more importance to the imponderables of human performance. In this respect, co-operative education is an important step forward in the most effective use of human capacity, and as such warrants

From their junior year on, co-operative students receive careful guidance and screening.

at least the respect and importance accorded any technique for increasing industrial efficiency.

Engineering in industry differs considerably from engineering in college. Although technical proficiency is of great importance, the emphasis in industry is on a responsible attitude and ability to co-operate with associates. In a survey of 1500 successful professional engineers, Doctor C. R. Mann of the Carnegie Foundation gives the following weights to factors influencing engineering success:

Character	– 41
Judgment	– 17½
Efficiency	– 14½
Understanding Human Nature	– 14
Technical Knowledge	– 13

It is significant that personality characteristics receive a total of 72½ points while technical considerations receive but 27½ points. Philco, for example, feels that a place can be found for any man with desirable personality traits. However, even the technically brilliant are rated poor employment risks when lacking acceptable personal characteristics. The pressure of

(*Continued on page 34*)

CORNING... DOES THE UNBELIEVABLE WITH GLASS

A new kind of light

where it will lead nobody knows

Soon it will be possible for you to step into your home or office and turn on a light that's different from any you've ever used before.

From a panel in the ceiling will come even, glareless rays to shine on your desk, your chair, your table—but never with uncomfortable brightness, never in your eyes.

The light itself will come from electric bulbs or tubes like those you use now. But it will *behave* far differently because it will shine through a ⅛-inch sheet of a new kind of glass—Fota-lite—a recent development of Corning Glass Works.

Formed inside this sheet is a crisscross pattern of strips of white glass extending through the full thickness of the glass. The squares enclosed by the white strips are crystal clear.

Light from the bulb above—shining through this patterned glass at slantwise angles—is diffused and causes no glare. You get an even, soft light through the entire room—as well as light channeled directly downward through the clear squares to the objects you need to see closely.

This new glass is made by mixing small amounts of rare metals in with the sand before it is melted to form glass. These materials make the whole sheet of glass photo-sensitive—through and through—so that any desired design (such as the one mentioned) may be formed inside the glass by a special process.

In fact, similar photo-sensitive glass is currently being used to print photographs in glass—pictures that can last for thousands of years.

Use of Fota-lite for indoor lighting is its first industrial application. Many other applications—such as its use in instrument panels for cars, in street lighting, and in illuminated signs—are being thoroughly explored.

In 98 years of glass-making Corning has developed glass into one of the most versatile engineering materials there is. There are more than 50,000 glass formulas on file at Corning, and the number is growing continually as new developments such as this photo-sensitive glass come out of the laboratory.

That's a good thing for you to remember. For some day, when you've picked the business you want to work in, one of these glass developments—or one now in the research stage—may be just the material you'll be looking for to improve a product or a process.

CORNING GLASS WORKS
CORNING, NEW YORK.

Additional steam for power generation at the Hudson Avenue Station of Consolidated Edison Company of New York, Inc., will be supplied by the World's most powerful boiler—now on order. High as a 14-story building, it will have a continuous output of 1,300,000 lbs. of steam per hr.—25% more than its nearest rival also on order for the same utility. The volume of water converted hourly into steam by this unit would fill over 2½ million tall tumblers—enough to serve 8 glassfuls a day to every resident in Greater New York City; its hourly coal consumption would heat an average home for over 6 years!

Making boilers that make history is an 80-year-old story with B&W. So, too, are pioneer advancements in many other fields.

Through its great diversity of progressive activities B&W offers unusual career opportunities to technical graduates in research, engineering, production, sales and other vocations.

World's Largest Boiler for World's Largest Steam-Electric Plant

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
85 Liberty Street, New York 6, N. Y.

N-65

co-operative education in action

(*Continued from page 32*)

academic requirements at M. I. T. often tends to place undue emphasis on the technical phases of education to the detriment of equally important social aspects. In this respect, the importance of the humanities and extracurricular activities cannot be overemphasized.

Although the co-operative absences from M. I. T. might appear to hinder participation in student activities, actually co-operative responsibilities stimulate such endeavors. The co-operative student body contains a disproportionate representation of men prominent in all phases of college life. The development of leadership qualities is a particularly important aspect of co-operative education.

Inherent aptitudes are fixed at birth, but the extent to which these aptitudes may be developed depends entirely on application and enthusiasm. In short, attitude is as important as aptitude. The co-operative companies hope that the student, for his own benefit, be willing, even eager, to do his best in any given assignment. Attitude influences assignment to the more desirable positions in future terms, and it largely determines the knowledge and experience derived from co-operation.

Emerson said, "Education is preparation for action," and industry's rewards are in proportion to action even more than education. The co-operative course, by teaching the student engineer to translate education into action, prepares him for the difficult transition from college to industry. Co-operation teaches the student to produce, and production, not knowledge alone, determines success in industry. The practical experience helps the student to "impedance-match" his abilities to an engineering position for optimum "power-output."

Most college sophomores have but the vaguest idea of what they may expect from industry and what industry expects from them. Their plans for the future are uncertain because they lack knowledge and experience upon which to base a sound course of action. Should they plan for executive careers, or are their talents strongest in technical work? What are the opportunities in sales and manufacturing? Do their interests tend toward detailed and extended theoretical investigations, or would they be happier in design and construction? Briefly, where may the able and willing man find greatest professional satisfaction and success; where in the broad engineering spectrum is his resonance point? These questions cannot be answered by guesswork, and scientific method requires specific and detailed information which is ordinarily unavailable to the sophomore, or to the senior for that matter. The co-operative program affords opportunity to secure such information by actually living and working with engineering. The several co-operative assignments allow the student to observe, discuss, and evaluate engineering from a number of different aspects. He benefits by the advice of successful experienced engineers, and he profits by hearing of their successes and mistakes. Co-operative education prepares, not for a job, but for a career.

DU PONT Digest

For Students of Science and Engineering

TEN UNIVERSITIES TO BENEFIT BY GRANTS FOR UNRESTRICTED FUNDAMENTAL RESEARCH

With a view to stock-piling basic knowledge, the Du Pont Company has announced a program of grants-in-aid for the college year 1949-50 to 10 universities for unrestricted use in the field of fundamental research in chemistry.

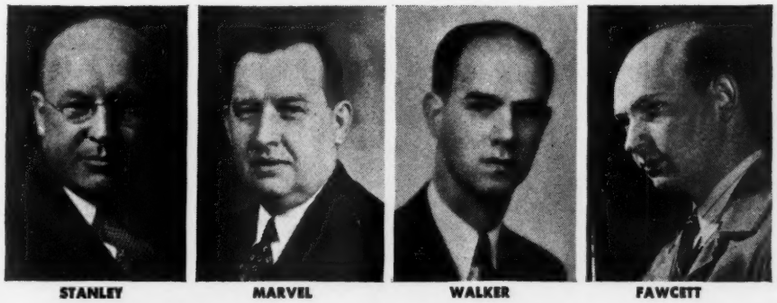
The grants-in-aid of $10,000 each are to be used for research that has no immediate commercial goal. The universities themselves are to select the projects in which the grants will be employed, and results of the research are to be freely available for publication.

Du Pont's purpose in offering the grants is to help insure the flow of fundamental knowledge in science upon which the future industrial development of our country is so dependent. It is intended that the funds be utilized for such expenses as employing additional research personnel or lightening the teaching load of a professor who is eminently capable of research of a high order. They may also be expended for the purpose of obtaining supplies, apparatus or equipment.

This program of grants-in-aid is largely experimental. However, it is Du Pont's hope, should the program work out satisfactorily, to continue each grant for a period of five years.

The 10 universities to which grants-in-aid are being offered are California Institute of Technology, Cornell, Harvard, Massachusetts Institute of Technology, Ohio State, Princeton, Yale, Illinois, Minnesota and Wisconsin. Du Pont fellowships are also offered at these institutions.

Four of Many Outstanding Du Pont Fellowship Winners



STANLEY MARVEL WALKER FAWCETT

Dr. Wendell M. Stanley, at University of California, is Chairman of the Department of Biochemistry in Berkeley and in the Medical School at San Francisco; Director of the Virus Laboratory. Bachelor's degree at Earlham College, 1926; M.S. at Illinois, 1927 and Ph.D. in Organic Chemistry, 1929. Honorary Doctor's degrees from five prominent American universities and the University of Paris. Has received more than 10 medals and awards for distinguished work in chemistry and biochemistry; co-recipient of the Nobel Prize in Chemistry in 1946. Du Pont fellow at Illinois in 1928-29.

Dr. Carl S. Marvel, Professor of Organic Chemistry at the University of Illinois since 1930, received his A.B. at Illinois Wesleyan University in 1915; A.M. at Illinois, 1916 and Ph.D. in Organic Chemistry, 1920; Sc.D. (honorary) at Illinois Wesleyan, 1946. President American Chemical Society, 1945; Director 1944-46. Has received numerous honors such as the Nichols Medal and memorial lectureships at outstanding universities. Du Pont fellow at Illinois in 1919-20. Consultant on Organic Chemistry to the Du Pont Company at present.

J. Frederic Walker is a Research Supervisor on formaldehyde products in the Electrochemicals Department. Trained at Massachusetts Institute of Technology. Awarded Bachelor's degree in Chemistry, 1925; Master's degree 1928, Ph.D. in Organic Chemistry, 1929. Author: "Formaldehyde Chemistry," "Organic Chemistry of Sodium," "History of Chemistry." Du Pont fellow in 1926-27.

Frank S. Fawcett is now doing synthetic organic research with Du Pont's Chemical Department. Received Bachelor's degree in Chemistry, Furman University, 1940; Master's degree Pennsylvania, 1944; Ph.D. in Organic Chemistry, Massachusetts Institute of Technology, 1948. Du Pont fellow at M.I.T. in academic year 1947-48.

77 DU PONT FELLOWSHIPS MADE AVAILABLE TO GRADUATE STUDENTS

Again in the academic year 1949-50, the Du Pont Company is awarding post-graduate and post-doctorate fellowships to universities throughout the country.

This is a continuation of the company's 30-year-old plan to encourage advanced studies in the fields of chemistry, physics, metallurgy, and engineering.

It is hoped that the plan will continue to help maintain the flow of technically trained men and women who will go into teaching and research work at the universities and into technical positions in industry. Some of them, as in past years, may come to work for Du Pont when they finish their studies, but there is no obligation to do so; fellowship holders are free to enter any field of activity they choose.

What Fellowships Provide

Each post-graduate fellowship provides $1,200 for a single person or $1,800 for a married person, together with an award of $1,000 to the university towards tuition and fees. Each post-doctoral fellowship provides $3,000 for the recipient and $1,500 to the university.

The students and their research subjects will be selected by authorities of the 47 universities participating. In this year's program, 45 of the post-graduate fellowships are in chemistry, 4 in physics, 15 in chemical engineering, 5 in mechanical engineering and 2 in metallurgy. There will be 6 post-doctoral fellowships as an incentive to those who would prefer to remain in academic work in order to obtain additional advanced training in chemistry.

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

Entertaining, informative — Listen to "Cavalcade of America" Monday Nights, NBC Coast to Coast

All this . . just for a Spring?

SURE . . . . mechanical spring design requires a firm grasp of fundamental facts and formulas. But there's a practical side, too, that often eases the way in many applications. When the time comes to apply your theory to actual work, remember Wallace Barnes as a friendly, helpful spring source — with a well-rounded knowledge of springs and springmaking that comes from long years of leadership in the field.

Wallace Barnes SPRINGS

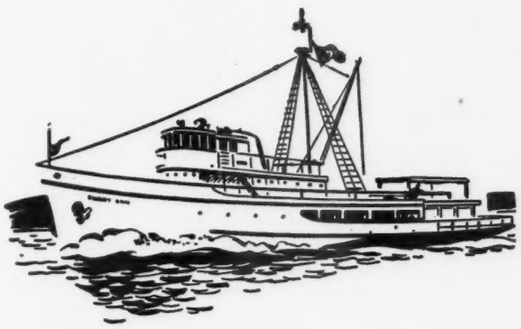
SMALL STAMPINGS • WIRE FORMS • HAIRSPRINGS • COLD ROLLED SPRING STEEL

WALLACE BARNES COMPANY
BRISTOL, CONN.

DIVISION OF THE ASSOCIATED SPRING CORP.

AND IN CANADA, THE WALLACE BARNES CO., LTD., HAMILTON, ONTARIO

Another page for **YOUR BEARING NOTEBOOK**

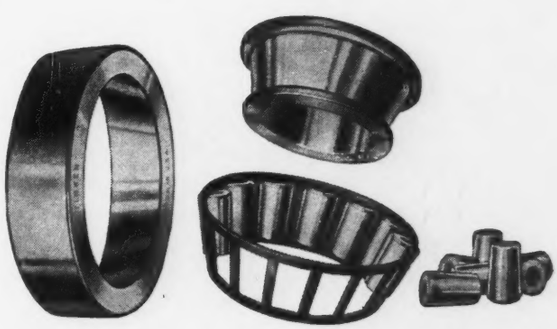


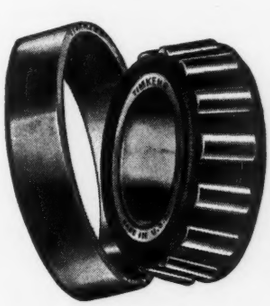
How to keep a hold cold

Both time and tuna are lost if the refrigeration unit breaks down while a fishing boat is at sea. Engineers insure dependability in sea-going ice machine compressors by specifying Timken® tapered roller bearings on crankshafts. Because of their tapered design, Timken bearings carry any combination of radial and thrust loads. With Timken bearings on the crankshafts, friction and lateral play are minimized. Shafts are held in rigid alignment. Wear and maintenance are reduced.

Why does TIMKEN® lead in bearing design?

The tapered roller bearing was pioneered by Timken and every important tapered roller bearing improvement since has been introduced by Timken. For example, Timken developed the one-piece multiple perforated cage to insure exact spacing of the rollers. And to provide positive roller alignment, Timken introduced wide area contact between the roll ends and the ribs. For almost fifty years this leadership in design has helped make Timken bearings first choice with engineers in every field.





TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

Want to learn more about TIMKEN bearings?

Some of the important engineering problems you'll face after graduation will involve bearing applications. If you'd like to learn more about this phase of engineering, we'll be glad to help. For additional information about Timken bearings and how engineers use them, write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

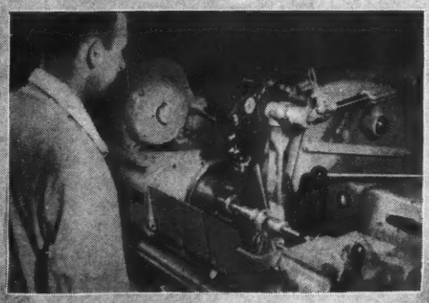
NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◐ AND THRUST —◐— LOADS OR ANY COMBINATION ✳

1/30 the thickness of this page is 1/10,000 of an inch

1/10,000 of an Inch is Everyday Grinding Accuracy

MANY thousands of the products which serve us so faithfully in our home lives, in college and in business — such as the refrigerator, the automobile, the airplane, the machines in office, laboratory and plant — owe their dependability and long life to the accuracy of grinding. Many have parts ground to limits as fine as *a tenth of a thousandth of an inch* (one thirtieth the thickness of this magazine page) by Norton grinding machines and Norton grinding wheels.

And many parts are still further refined, both for accuracy and surface finish, by Norton lapping machines. The work turned out on a production basis by these unique Norton machines is measured in *millionths of an inch* — must be gauged by complicated optical instruments making use of light rays.



When industry has a production problem which involves extreme accuracy or high surface finish, or both, it turns to Norton . . . for Norton has a large and capable staff of engineers, highly trained experts on abrasives, grinding wheels, grinding machines, and lapping machines.

NORTON COMPANY • WORCESTER 6, MASS.

(Behr-Manning, Troy, N. Y. is a Norton Division)

NORTON

ABRASIVES — GRINDING WHEELS — GRINDING AND LAPPING MACHINES
REFRACTORIES — POROUS MEDIUMS — NON-SLIP FLOORS — NORBIDE PRODUCTS
LABELING MACHINES (BEHR-MANNING DIVISION) COATED ABRASIVES AND SHARPENING STONES

lightning quick

(*Continued from page 19*)

by the National Research Corporation. The process involves evaporating a thin metallic plate upon the dielectric paper. The possible saving in weight is roughly forty per cent.

There are four main components involved in power supplies: batteries and vibrator (if the unit is portable), a transformer, and a rectifier.

Although there is at least one portable unit on the market with dry batteries, most units use rechargeable wet cells. The use of dry batteries to charge the energy storage condensers directly does not appear practical with the batteries available at present. Many light-weight wet cells were designed for war uses, but the batteries often were intended for very short life applications and are therefore not well suited for use in portable flash units. Not only the charging current but also the idling current must be considered in design specifications, particularly if electrolytic condensers are used.

The vibrator section of the power supply can be one of two basic types, synchronous or non-synchronous. At present most units use non-synchronous vibrators to deliver power to the transformer primary. The use of a synchronous vibrator eliminates the need for a rectifier, but increases the voltage at which one set of contacts must be operated. The voltage at which these contacts must operate can be cut in half if the condensers are charged in parallel and then switched in series to supply the flashtube, but this switching operation makes it impossible to use electronic synchronization.

Portable units normally use selenium oxide rectifiers since they are much lighter and require no filament current. Studio units may use selenium or copper oxide rectifiers, vacuum tube rectifiers, or even thyratrons. The choice is not critical, since the effect on size or weight is inconsequential for a studio unit, even if an otherwise unnecessary filament transformer must be added.

Electronic flash units have been adapted to a wide variety of applications. Their further development seems to depend primarily upon advances in the design of the components involved, in particular capacitors and flashtubes. From the consumer standpoint, a wide variety of units is available to fit almost any camera or application.

THE HYDROSTATIC TEST

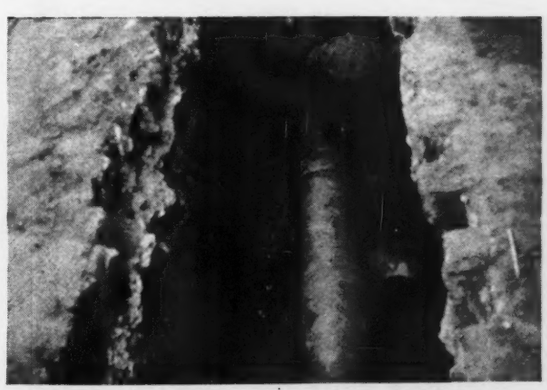
Nobody can buy a length of cast iron pipe unless it has passed the Hydrostatic Test at the foundry. Every full length of cast iron pipe is subjected to this test under water pressures considerably higher than rated working pressures. It must pass the test or go to the scrap pile.

The Hydrostatic Test is the final one of a series of routine tests made by pipe manufacturers to assure that the quality of the pipe meets or exceeds the requirements of standard specifications for cast iron pressure pipe.

Few engineers realize the extent of the inspections, analyses and tests involved in the quality-control of cast iron pipe. Production controls start almost literally from the ground up with the inspection, analysis and checking of raw materials—continue with constant control of cupola operation and analysis of the melt—and end with inspections and a series of acceptance and routine tests of the finished product.

Members of the Cast Iron Pipe Research Association have established and attained scientific standards resulting in a superior product. These standards, as well as the physical and metallurgical controls by which they are maintained, provide assurance that cast iron pipe installed today will live up to or exceed service records such as that of the 130-year-old pipe shown.

Cast iron pipe is the standard material for water and gas mains and is widely used in sewage works construction. Send for booklet, "Facts About Cast Iron Pipe." Address Dept. C., Cast Iron Pipe Research Association, T. F. Wolfe, Engineer, 122 So. Michigan Ave., Chicago 3, Illinois.



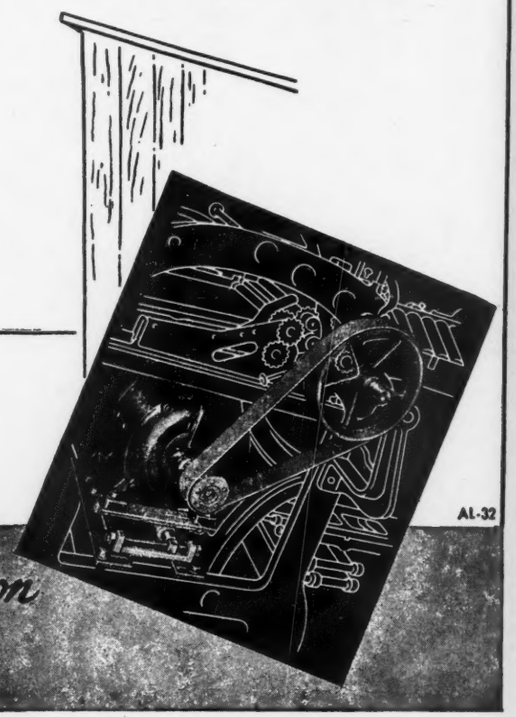
Section of 130-year-old cast iron water main still in service in Philadelphia, Pa.

CAST IRON PIPE SERVES FOR CENTURIES

Modern power applications call for leather, too

There was something mighty impressive about those old-time woodshed sessions with Dad's leather razor strop. Dad had a very effective way of putting power to work via leather.

Here's the modern way to transmit power by leather in industry. The tension-control motor base puts the inherent power-carrying advantage of leather to work in compact space. The base plus the "single-pull" leather belt make a drive package that is "right" for many vital spots in today's industry.



AL-32

American LEATHER BELTING Association

Headquarters for Authentic Power Transmission Data

41 PARK ROW, NEW YORK 7, NEW YORK

TIPS on TAPES

NO. 3 OF A SERIES

Buy no tapes until you have seen Lufkin Chrome Clad Tapes. Markings easily read in bright or poor light. Markings sunk below the surface for extra wear protection. A tough, flexible steel base multi-plated for extra rust resistance. Ask your distributor for them.

EASY TO READ MARKINGS THAT ARE DURABLE

Lufkin Chrome-Clad "Super Hi-Way", "Pioneer" and "Michigan" are *New and Better Chain Tapes.* Chrome plating over rust resistant base and multiple coats of electroplating gives a hard, smooth, dull, chrome-white surface. Wear and corrosion resistant. Jet black figures are easy to locate and read. Write for illustrated leaflet giving complete details.

TAPES - RULES
The Lufkin Rule Co.

LUFKIN

PRECISION TOOLS
Saginaw, Michigan

Since 1905

National Electric has manufactured quality wiring systems and fittings for every electrical requirement.

NOW 44 years later National Electric is the World's Largest Producer of electrical roughing-in materials.

National Electric Products Corporation
Pittsburgh 30, Pa.

The Early Birds Are Out...

TIME FOR SPRING ROAD CONDITIONING

WITH Columbia Calcium Chloride

Calcium Chloride's remarkable affinity with water is put to good use in conditioning secondary roads, driveways, tennis courts and recreation areas. Spring and summer treatment consists of spreading the flakes over the surface . . . the chemical helps the subsoil to retain moisture, prevents cracking and formation of dust, provides firmer, smoother surfaces requiring less maintenance. In winter, calcium chloride mixed with sand or cinders is used to skidproof icy roads and walks.

These treatments are but a few of numerous uses of Calcium Chloride. Other important commercial applications include refrigeration, concrete curing, dust and freeze-proofing of coal and air dehumidifying. Columbia is one of the leading producers of Calcium Chloride, as well as Chlorine Caustic Soda, Soda Ash and other alkalies and related chemical products. Pittsburgh Plate Glass Company, Columbia Chemical Division, Fifth at Bellefield, Pittsburgh 13, Pa.

COLUMBIA CHEMICALS

PAINT • GLASS • CHEMICALS • BRUSHES • PLASTICS

PITTSBURGH PLATE GLASS COMPANY

briefing the news

Electron Tube with Memory . . .

The image from a radar scope can now be retained and intensified by an electron tube which stores radar patterns and oscilloscope traces for as long as a minute. The tube is used between the time when the radar beam is received and when it is reproduced on a television kinescope.

Two beams are aimed at a target in the tube. This target is of a quadruple layer construction. There are respectively, a layer of copper screen (500 wires to the inch); a film of collodion one millionth of an inch thick; a layer of aluminum four millionths of an inch thick; and a layer of alternately insulating and conducting material.

The beams which hit the target are of two types. One is the radar beam which "writes" on the target surface; the other is an iconoscope beam which "reads" from the surface. The target is not light sensitive but reacts to electrical charges.

The iconoscope beam prepares the target for the radar beam by building up a suitable constant voltage on it. When the radar beam picks up a reflection of some material object, the radar beam of electrons is directed at the target. The voltage on the target is discharged by the radar beam. The iconoscope scanning beam has the effect of bringing the voltage back to the equilibrium point and this produces a signal on the target which is magnified and relayed to the kinescope.

Sine the iconoscope beam scans at a rate of thirty times a second, and can take as long as two thousand scans to bring the signal area back to voltage equilibrium, the image will be retained for 2,000/30 or roughly sixty-seven seconds.

Co-ordination of the speeds of the iconoscope and radar beams results in a kinescope signal with a high level of brightness.

If the iconoscope beam is made slower than the radar beam, the resultant image will indicate the direction of motion of the object being pictured.

The most important application of the tube is expected to be in Teleran. This is the air navigation aid in which a detailed picture containing a radar pattern, associated ground map, and other information is televised to an airplane from the ground. The new memory tube will make it possible to transmit a stronger and longer lasting image to the airplane.

Mutations through Ultrasonics . . . .

The primary method of producing artificial mutations in plants and animals has, up to now, involved x-rays. Recent research seems to indicate that mutations can also be produced by subjecting living material to sound waves of certain frequencies.

Dr. R. H. Wallace of the University of Connecticut claims that he has been producing mutations by this method for over a year. The mutations that were produced with the fruit fly, or Drosophila, are the same types that are produced through x-rays or other radiations.

Similar work in which young seedlings were exposed to ultrasonic vibrations have given many interesting modifications in plants. Some of these mutations may be of agricultural importance. A new sunflower produced at the University of Connecticut shows promise along this line.

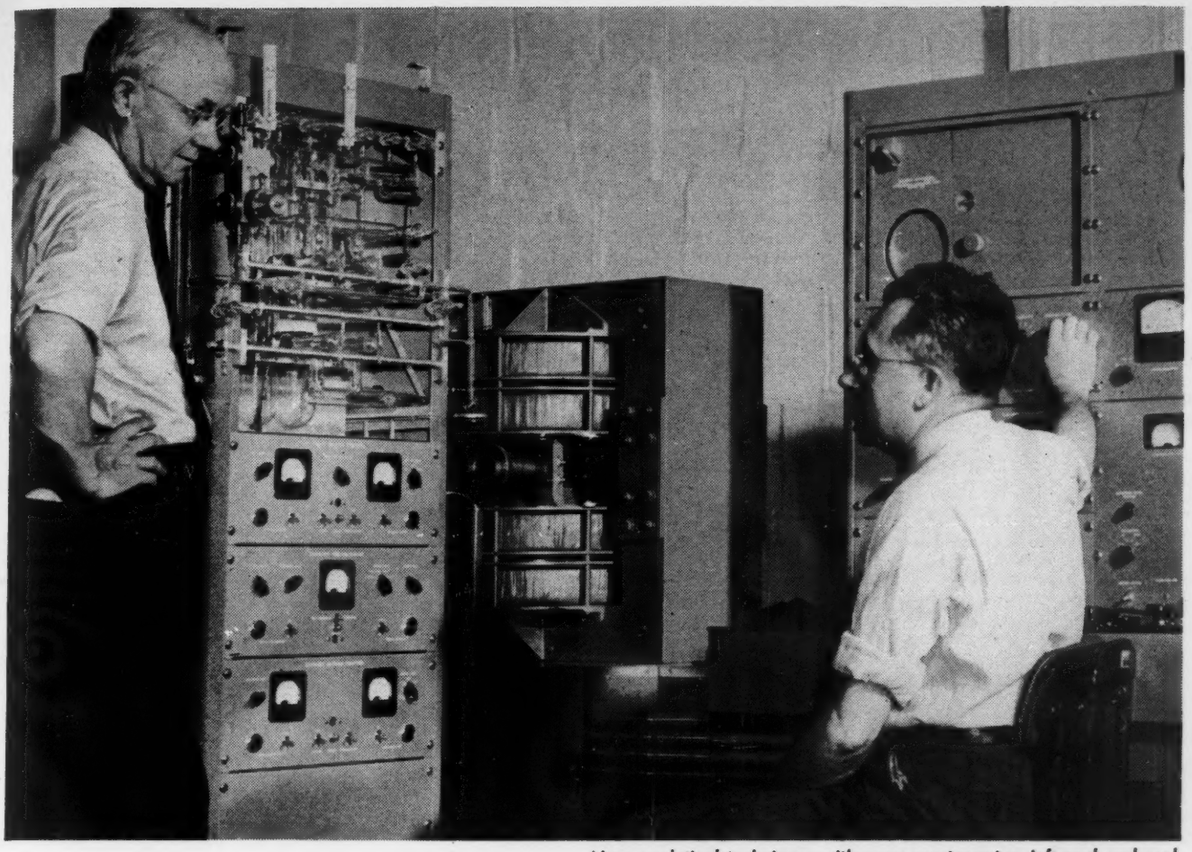
Reading Machine . . .

An electronic device which converts reading matter into the sounds of individual letters has been developed by the R. C. A. laboratories.

The device scans a line of type with a mechanism containing a miniature cathode ray tube. Each letter is scanned vertically with a pinpoint of light at the rate of 500 cycles per second. The scanning spot pauses momentarily at several points along its track, thereby creating the effect of a series of spots arranged in a vertical line. The spots of light are not present continuously but are made to appear one after another in a time sequence. If the series of spots forming the vertical line is now moved manually along the lines of type, the light normally reflected by the white paper will be interrupted by the black portions of the letters. These interruptions are transformed into electrical impulses by means of a phototube and amplifier.

As a result of the high-speed vertical scanning and the manual scanning along the lines of print the signal output of the phototube amplifier will be in the nature of the scanning frequency modulated by the interruptions of light. The total number of impulses will be unique for most letters of the alphabet.

A magnetic tape reproducer is so arranged that as a letter is recognized a single recording of that letter is reproduced through a loudspeaker. The individual letter sounds are recorded on separate discs driven by friction.



New analytical techniques with mass spectrometer, infrared and pod equipment. Refinery Chief Chemist G. Lansing, Washington & Jefferson, '11, Cincinnati '17, J. A. Simpson, N. Y. U. '38, Stevens '43.

What should a man work For?...

Put that question to either of the men shown here, and he'd answer about like this:

"Well, you could say a man works for a living, but there's more to it than just that. A man has his self-respect to keep. He wants to work at a job he likes. He wants to do something useful. He wants fair pay and steady hours—with some time to himself and his family. He wants a chance to get ahead and he wants to save some money. And he wants some security in case of accident or sickness. Then, when his working years are done, he wants to know he can retire on an annuity."

Today, in Esso Standard Oil Company, 28,000 men and women have jobs which offer exactly these things.

They have such jobs because of a company policy that was set up over 30 years ago—and developed side-by-side with our workers ever since. It is a policy based on the belief that the heart of a business is its people—that the best possible jobs attract the best possible workers.

Workers in this company today have everything outlined in the statement above—including vacations with pay, sickness benefits, cash savings in a Thrift Plan, and the opportunity to retire with income for life.

Our 28,000 workers, for instance, have now been with us on the average for 12 years—8,400 of them more than 20 years.

But this policy hasn't grown from "generosity" alone. It's a practical, common-sense *business* policy, and a good one. Because we know that the best way for Esso Standard to help meet the growing oil needs of the world is . . . by doing our best to help our workers get "the things a man works for."

Esso

ESSO STANDARD OIL COMPANY

THE TECH ENGINEERING NEWS INDEX

VOLUME XXX

This index covers November to April, 1948–1949. There is no June issue in Volume XXX.

	Month	Page
A		
Air Engines	March 1949	172
Alfandry, Marc L. '50		
Industry's Westward Ho!	March 1949	178
Middle East Jig-Saw Puzzle	November 1948	16
Alice in Dimensionland	January 1949	100
B		
Backus, Milo M. '52		
Wiener — Paul Bunyan of M. I. T.	March 1949	170
Bartlett, Luis H.		
Alice in Dimensionland	January 1949	100
Bloch, Alex, '50		
Air Engines	March 1949	172
C		
The Cat is Here	February 1949	135
D		
Diamond, Fred, '50		
Rival for the Vacuum Tube	November 1948	20
Dimensional Analysis	January 1949	104
Donovan, Robert, '52		
Inventors	February 1949	140
E		
Eames, Earl W., '49		
Foreign Student Summer Project	November 1948	9
Eastgate	December 1948	62
Education	April 1949	14
Evolution of the Ford	December 1948	53
F		
Field, George, '51		
Shooting Stars	January 1949	94
Flomenhoft, Hubert		
The Institute Flyboys	February 1949	132
Fluorine	April 1949	16
Foreign Student Summer Project	November 1948	9
I		
Industrial Research in Action	April 1949	6
Industry's Westward Ho!	March 1949	178
Infra-Red Photography	March 1949	176
The Institute Flyboys	February 1949	132
Inventors	February 1949	140
J		
Jenkins, Roy, '50		
Spanning the Mystic	March 1949	181
Eastgate	December 1948	62
Jordan, Charles, '49		
Evolution of the Ford	December 1948	53
K		
King, Kenneth, '52		
Industrial Research in Action	April 1949	6
Kopple, Kenneth, '51		
Photo-Offset	December 1948	58
Fluorine	April 1949	16
Kraus, Alfred, '49		
Mass Spectrometers	April 1949	18
L		
Levine, Jerry, '51		
Wood for Thought	November 1948	18
Londiniensis		
Education	April 1949	14
Lucas, William, '51		
Fluorine	April 1949	16
M		
Mass Spectrometers	April 1949	8
Middle East Jig-Saw Puzzle	November 1948	16
Mineral Policy	February 1949	138
Morrow, Phillip, '52		
Infra-Red Photography	March 1949	176
O		
"of driving gentle machinists mad"	January 1949	98
P		
Prof. Parks, Roland		
Mineral Policy	February 1949	138
Photo-Offset	December 1948	58
Problem of the Bad Penny	January 1949	97
Q		
Question Mark, Period	February 1949	142
R		
Rival for the Vacuum Tube	November 1948	20
Rosenbaum, Madge, '51		
Women in the Sticks	December 1948	60
S		
Saltsman, Charles, '52		
Revolution in Yachting	April 1949	8
The Cat is Here	February 1949	135
Scoledes, George, '52		
Waging the Peace-Air Phase	December 1948	57
Shooting Stari	January 1949	94
Stevenson, John, '49		
Problem of the Bad Penny	January 1949	97
T		
Tardini, Giuseppi		
Training Engineers in Italy	April 1949	12
Training Engineers in Italy	April 1949	12
V		
Vidal, Robert, '49		
That "Wild Blue Yonder"	November 1948	11
W		
Waging the Peace — Air Phase	December 1948	57
Wiener — Paul Bunyan of M. I. T.	March 1949	170
That Wild Blue Yonder	November 1948	11
Weber, Helmut, '50		
"of driving gentle machinists mad"	January 1949	98
Weiss, Max		
No Formulas Necessary	January 1949	104
Westheimer, Paul '52		
Infra-Red Photography	March 1949	176
Women in the Sticks	December 1948	60
Wood for Thought	November 1948	18
Y		
Revolution in Yachting	April 1949	8

BRIEFING THE NEWS TOPICS

November, page 42

Plastic Roads
Quanta per Photographic Grain
Mechanical Properties of Human Bones

December, page 86

Salary Statistics
Ultrafax
Spectrometers

January, page 122

Intermolecular Forces
Radioactivity Unit
Earth Time Inaccurate
Road Melts Snow

February, page 162

New Synchrotron
Ultrasensitive Emulsion
Low Temperature Spectroscopy

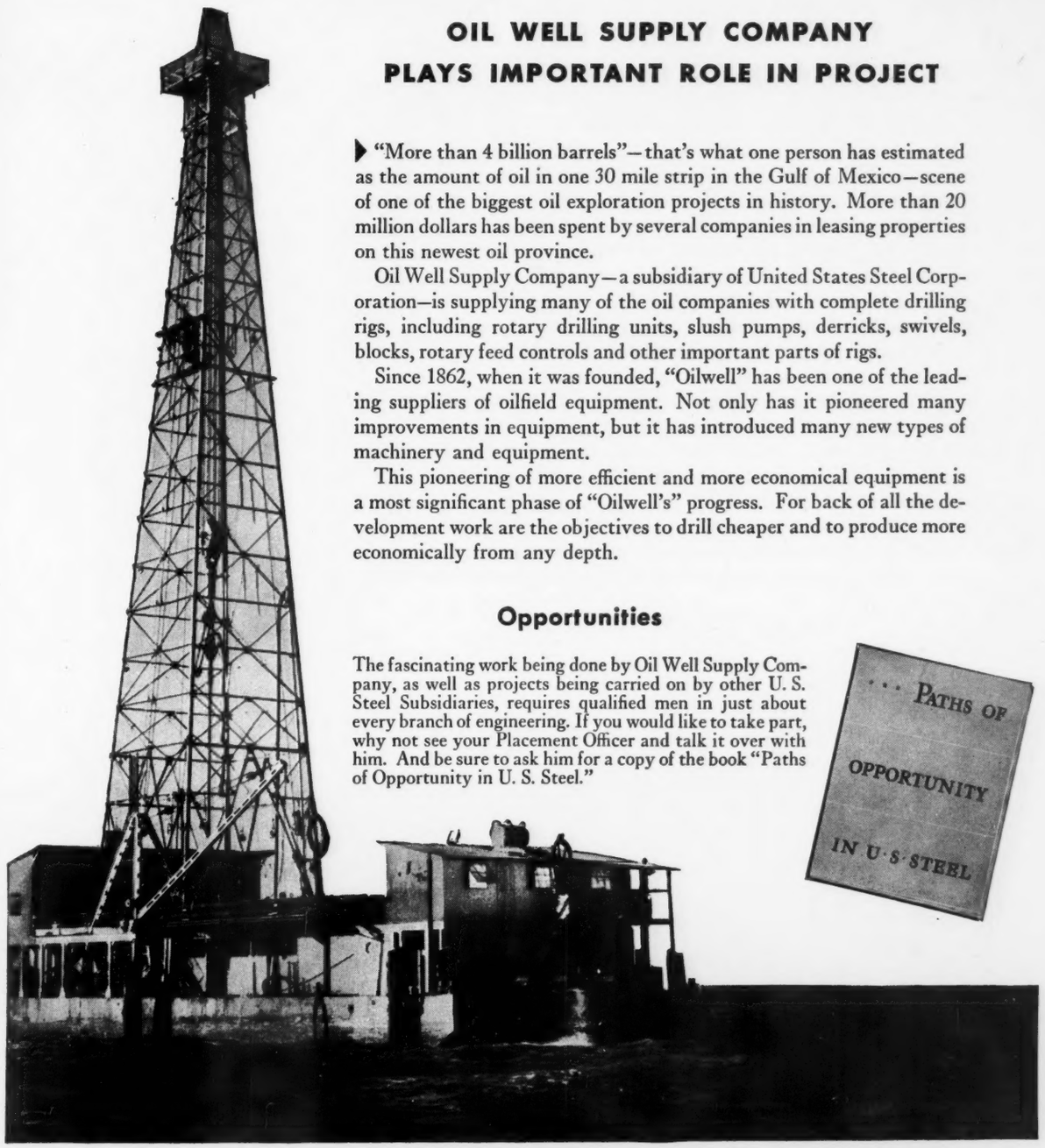
March, page 206

Electric Eels
Plating Tungsten
Alcohol Absorption
Boston Traffic Plan
Tracers in Metals

April, page 42

Warmer Light
Congealed Gasoline
X-Ray Image
Gas Detection
Dry Printing
Heat Photos
Light for Nothing

Gulf of Mexico is site of newest oil "boom"



OIL WELL SUPPLY COMPANY PLAYS IMPORTANT ROLE IN PROJECT

"More than 4 billion barrels"—that's what one person has estimated as the amount of oil in one 30 mile strip in the Gulf of Mexico—scene of one of the biggest oil exploration projects in history. More than 20 million dollars has been spent by several companies in leasing properties on this newest oil province.

Oil Well Supply Company—a subsidiary of United States Steel Corporation—is supplying many of the oil companies with complete drilling rigs, including rotary drilling units, slush pumps, derricks, swivels, blocks, rotary feed controls and other important parts of rigs.

Since 1862, when it was founded, "Oilwell" has been one of the leading suppliers of oilfield equipment. Not only has it pioneered many improvements in equipment, but it has introduced many new types of machinery and equipment.

This pioneering of more efficient and more economical equipment is a most significant phase of "Oilwell's" progress. For back of all the development work are the objectives to drill cheaper and to produce more economically from any depth.

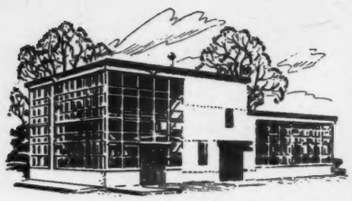
Opportunities

The fascinating work being done by Oil Well Supply Company, as well as projects being carried on by other U. S. Steel Subsidiaries, requires qualified men in just about every branch of engineering. If you would like to take part, why not see your Placement Officer and talk it over with him. And be sure to ask him for a copy of the book "Paths of Opportunity in U. S. Steel."

AMERICAN BRIDGE COMPANY · AMERICAN STEEL & WIRE COMPANY · CARNEGIE-ILLINOIS STEEL CORPORATION · COLUMBIA STEEL COMPANY
H. C. FRICK COKE AND ASSOCIATED COMPANIES · GENEVA STEEL COMPANY · GERRARD STEEL STRAPPING COMPANY
MICHIGAN LIMESTONE & CHEMICAL COMPANY · NATIONAL TUBE COMPANY · OIL WELL SUPPLY COMPANY · OLIVER IRON MINING COMPANY
PITTSBURGH LIMESTONE CORPORATION · PITTSBURGH STEAMSHIP COMPANY · TENNESSEE COAL, IRON & RAILROAD COMPANY
UNITED STATES STEEL EXPORT COMPANY · UNITED STATES STEEL PRODUCTS COMPANY · UNITED STATES STEEL SUPPLY COMPANY
UNIVERSAL ATLAS CEMENT COMPANY · VIRGINIA BRIDGE COMPANY

USS

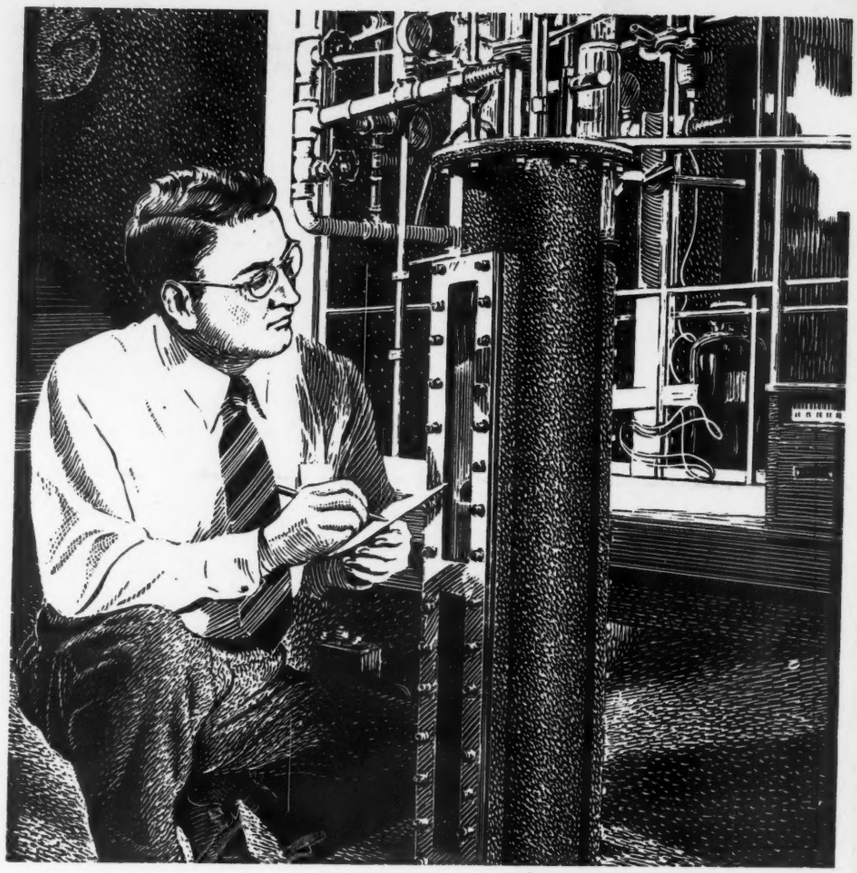
UNITED STATES STEEL



NEW LABORATORY UNIT, *part of G-E Research Laboratory, is the center of General Electric research into such low-temperature phenomena as . . .*

SUPER-FLUIDITY *of helium—meaning that at near-absolute zero it loses its viscosity, can spin forever . . . and*

SUPER-CONDUCTIVITY—*the loss of all electrical resistance by some materials below about 15° absolute.*



Near absolute zero, matter does strange things . . .

CORNELL UNIVERSITY
JUN

AT 455 degrees below zero Fahrenheit, liquid helium becomes a "superfluid." That is, it loses its viscosity; if it were to be set in motion like stirred coffee spinning in a cup, part of it would theoretically continue to spin forever.

It also becomes a "super-wetting" agent, meaning that it will creep up the sides of a container and flow over the edge.

Other types of matter develop the property of "super-conductivity." Columbium-nitride, for example, loses all electrical resistance below 15 degrees absolute. If an electric current were set in motion in a closed loop of this substance, it would in theory flow indefinitely.

These are some of the facts of cryogenics—the study of low-temperature phenomena—into which a group of young General Electric scientists are directing their investigations.

So far their studies are in only the earliest stages. But already the facts of this nether-world of temperature have aroused enough interest that with the building of a new Research Laboratory near Schenectady, a $250,000 laboratory unit has been especially constructed to aid and amplify their work.

Through its emphasis on research and creative thinking, through encouraging fertile minds to follow their own imaginative bent and by implementing their work with the best available facilities, General Electric remains "a place where interesting things are happening," and stays in the forefront of scientific and engineering development.

You can put your confidence in—

GENERAL ELECTRIC